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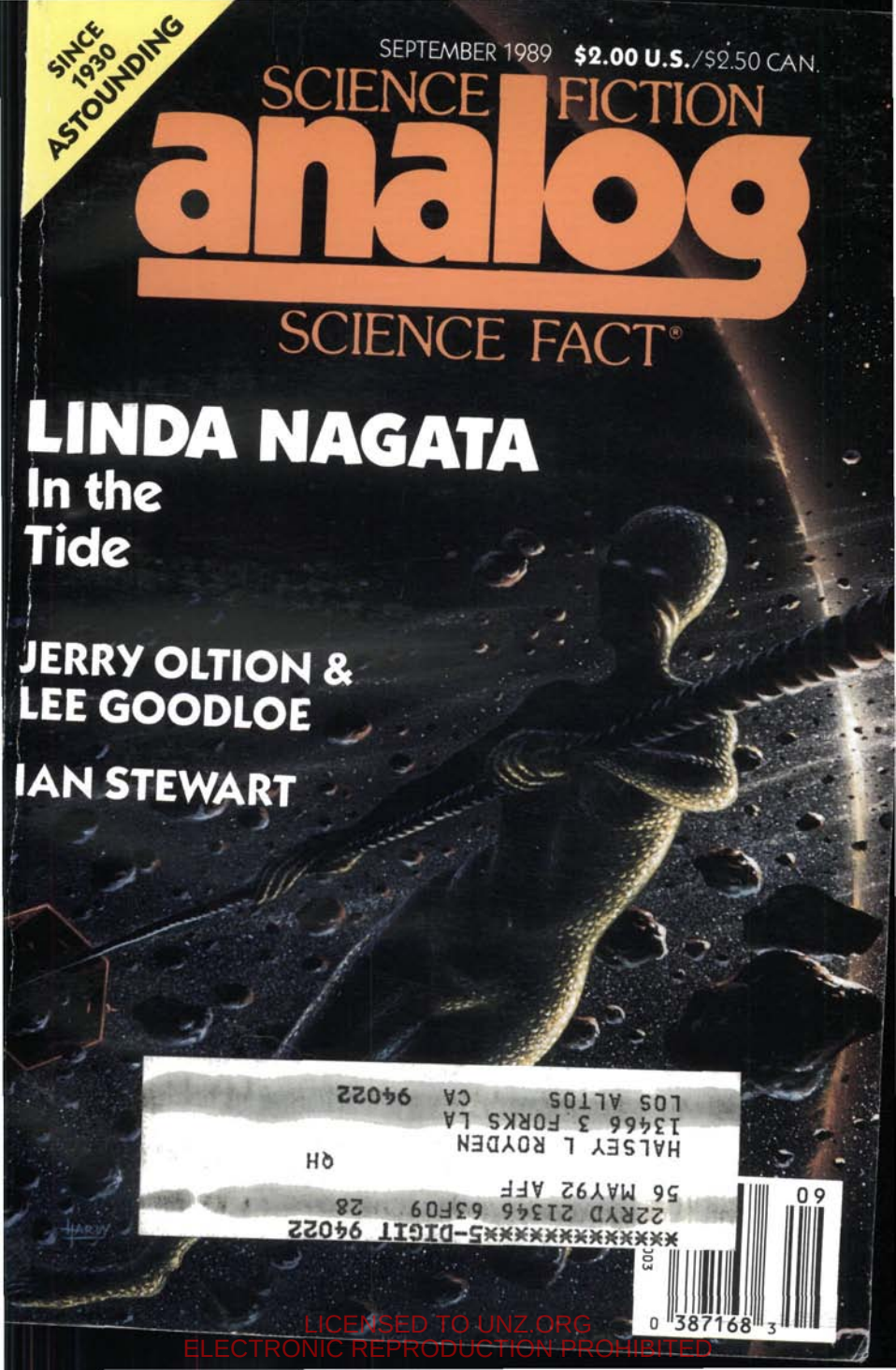

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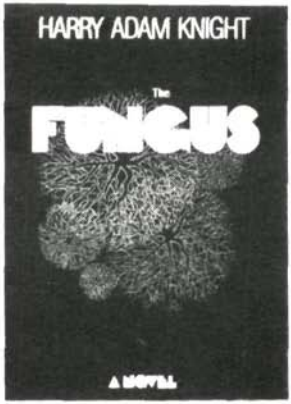

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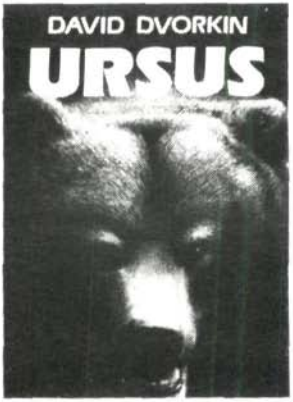

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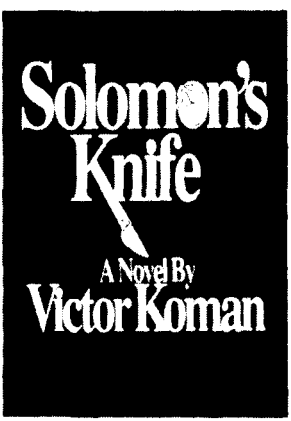

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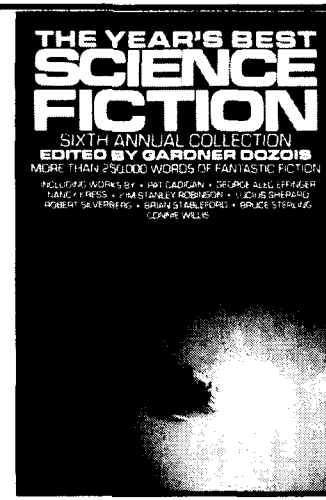

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Editorial

THE BLIND MEN, THE PLANET, AND THE WOLF

Stanley Schmidt

When you were very young, you probably heard the ancient fable of the blind men and the elephant. A group of blind men, all unable to see the elephant as a sighted man would, tried to determine its nature by feeling it. One, who happened to be standing by its side, concluded that the elephant was something like a wall. Another, grabbing its tail, perceived it as ropelike. Still another, feeling its leg, thought it most resembled a tree. It doesn't seem to have occurred to any of them to wonder whether his perceptions were in any way representative of the animal as a whole, or just part of it—which is, of course, the point of the fable.

That much seems obvious to most modern listeners or readers—but that doesn't always stop them from falling into the same sort of fallacy in new contexts. Let's talk, for example, about the weather.

In my neck of the woods, there's been a lot of talk about the weather during the last year or so. Last summer we had a humdinger of a heat wave, and much of the winter was uncommonly mild and dry. During both of these periods, a very frequent topic of conversation was, "Is this the dreaded greenhouse effect?" —often couched in the less tentative form, "This must be the dreaded greenhouse effect!"

Is it or isn't it?

Correct answer: I don't know, and neither do you.

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Important corollary: We'd both better pay attention and try to find out.

Please note carefully: the question is *not* whether the greenhouse effect really exists. That's fairly elementary physics, so well established that it won't support serious debate. The greenhouse effect *does* exist; and in simple cases it's pretty straightforward to calculate, and experimentally verify, how much temperature rise will occur when a certain amount of energy passes through a certain medium to a certain partially absorbing surface, and only part of it can get back out. This does happen, it has always happened, and the extent to which it happens will change when the properties of the system are changed.

The problem is that the Earth is by no means a simple system, and the changes human activities are undeniably producing in it are not simple changes. The greenhouse effect many people are concerned about is not the simple fact described in the preceding paragraph, but an overall increase in the average temperature of the planet caused by a global *increase* in the amount of heat retention by greenhouse effect. The question really being asked by those who ask, "Is this the dreaded greenhouse effect?" is, "Is this the *global increase* some models predict?"

And that's one that can't be answered quickly by an observer in one small region. A summer heat wave or mild winter in one part of the country is certainly *not* a global increase in anything. It may or may not be *part* of one; but you need a lot more than local, short-term data to determine whether it is. You may object that a heat wave covering a large part of this country is hardly "local," but that's "blind man and elephant" effect. In global terms, this *entire* country is local—the lower 48 states occupy something like 2% of the planet's surface. And a season or even a year is "short-term." I found it mildly amusing that when acquaintances were taking last summer's heat wave as strong evidence of increasing global greenhouse effect, nobody seemed to remember that the same year's *spring* had been many degrees *colder* than usual. During our springy January, nobody mentioned that December had set several *low* temperature records in the same area. On one of those January days, I recall hearing a radio announcer remark that New York had just established a record high in the 60's—while reading a cover letter from an author in Minnesota who was confined to his house by a combination of record snow and cold. Meanwhile Alaska was suffering a prolonged cold snap far worse than even its inhabitants were prepared for, and parts of the South had several atypically heavy snowfalls.

None of which proves a thing about whether or not an increase in global greenhouse effect is producing a massive change in Earth's climate. Please read that carefully: I didn't say it isn't, and I didn't say it is. I said only that *you can't tell* from such meager, arbitrarily selected data.

How, you may ask, can it *not* be happening? After all, I said earlier that the greenhouse effect is a well-established phenomenon, and it's quite clear that

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human activities are increasing concentrations of atmospheric constituents that exhibit it. Therefore it follows . . .

Yes, but the greenhouse effect is not the *only* effect that Really Happens. To determine whether it's doing major things to you, you also have to look at all the other things that are going on. That ain't easy, and all those effects interact. For example, some scientists have suggested that an increase in greenhouse effect would lead to an increase in cloud cover. That would increase the Earth's albedo (the fraction of sunlight reflected into space before it even reaches the ground), which would tend to produce a cooling trend—which might reduce or even reverse the heat buildup due to increased greenhouse effect. Furthermore, the energy output from the Sun itself varies appreciably, which can work with or

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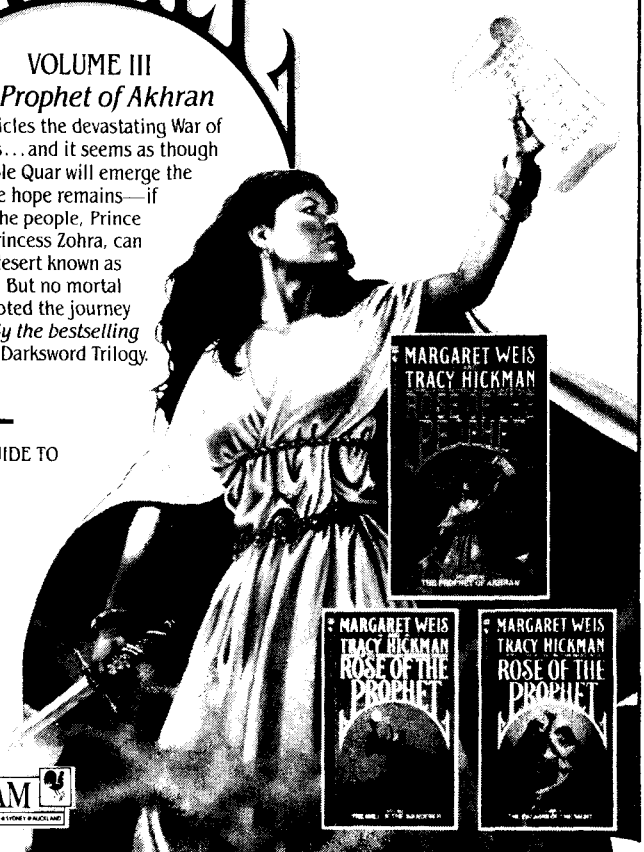

SPECTRA BANTAM

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against any changes originating in the atmosphere. For a variety of such reasons, the Earth has already shown numerous sizable climate changes, some of them quite recent even in terms of human history. (If you'd like a detailed account of them, you can find it in various places, such as under "Geochronology" in a late-model *Encyclopædia Britannica*—or the numerous references cited there.)

The important point is that you can't answer a global question about a long-range effect by looking at local events over a short period of time. Casual observers who assume the world is doomed because of a couple of heat waves in their neighborhood are, at best, panicking prematurely. On the other hand, there's the headline writer who wrote STUDY SHOWS NO WARMING DUE TO GREENHOUSE EFFECT across a story reporting a study finding no overall temperature rise in 100 years of weather records for the Lower 48. He's just as guilty of going off half-cocked—and perhaps lulling his readers into a false sense of security. *To determine whether a long-term, global change is occurring, you need long-term, global data.*

What you *don't* need is people of *any* persuasion claiming or believing that they know what's happening without full consideration of all available data, and dismissing those who disagree with them as not worth listening to. The greenhouse effect is just one of a whole complex of interrelated environmental problems, and one of the biggest obstacles to appraising and solving these problems is precisely this tendency of people with opposing views to shrug off their opponents. We often hear clashes between "environmentalists" and "anti-environmentalists," those labels typically being applied disparagingly by members of one group to the other (though "environmentalists" sometimes apply that one to themselves, with pride which they may or may not have earned). I consider myself an environmentalist, if the word is used carefully; but in general I dislike such labeling of the individuals who make up *any* group. And in this particular class of controversies, I've seen plenty to blame on both sides.

Historically, I was an environmentalist long before I ever heard the word, and certainly long before it became fashionable to be one. There have probably always been a few people who looked at some of the consequences of human activity and found them at the very least undesirable and unnecessary, and possibly dangerous. Until fairly recently, such people were a small minority and their views unpopular. Probably in most cases their views were little more than matters of personal preference plus intuitive suspicions about what objectively measurable problems might be developing. In this century, though, a good many scientists started doing quantitative research on such concerns as environmental pollution. As word spread, largely due to books such as biologist Rachel Carson's *Silent Spring* in the early 1960s, cleaning up the environment became a Popular Cause—a fad which peaked around 1970.

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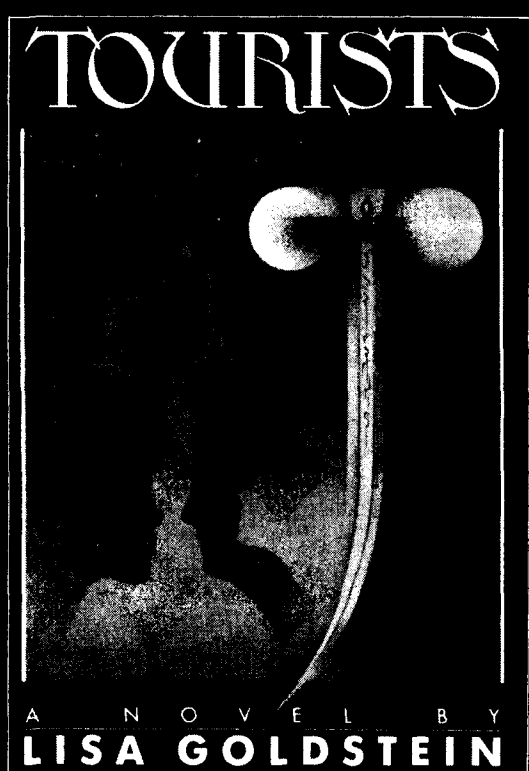

SIMON AND SCHUSTER

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Like any such fad, this one attracted a good many followers who had at best a dim understanding of the true nature and extent of the problems and what could or should be done about them. Even some of the scientists working on environmental problems became so wrapped up in their particular part of them that they have lost their perspective. Both they and their followers who were running more on emotion than on understanding sometimes got carried away with heated demand for actions which were not always rational. This tendency did their cause very little good. Just as fads attract fringe followers, so do they generate a reaction against themselves. Other people erroneously come to equate the most extreme and least rational expressions of a movement with the movement itself. So it came to pass that "environmentalist" came to be regarded and used in some circles as a dirty word.

Thereby further obscuring the fact that the whole business of "environmentalism" started off with a bunch of valid, important concerns. The fact that some individuals under that banner got carried away does not make those concerns any less valid or important. The fact that some environmentalists do more ranting than analyzing must not hide the fact that others have collected large quantities of hard data that cannot be wished away. The existence of environmentalist excesses in no way excuses anti-environmentalist excesses.

One of the latter is the tendency we've all sometimes seen to dismiss concerns about things like greenhouse effect by pointing out that there have been many prophecies of doom in the past, none of which have come to pass. That's a true observation. It is *not,* by any stretch of the imagination, a rigorously logical proof that there are no problems big enough to warrant serious concern.

There's another old fable, about a little boy who cried wolf. Unfortunately, when his elders came to his aid, no wolf was to be seen. After this happened a few times, the boy lost his credibility and the elders no longer paid any attention when he cried, "Wolf!"

Even when the wolf really came.

The parallel is obvious, as is the conventionally stated moral: "If you lie, people will stop believing you and someday it will get you into trouble." But the story really has at least *two* morals, and *both* apply to environmental problems like greenhouse effect.

It's all very well to point out, when people start getting very upset about greenhouse effect or holes in the ozone layer or whatnot, that the cry of "Wolf!" has been heard many times before, and turned out to be a false alarm. This serves as a reminder that evidence that looks convincing now may turn out not to be valid in the light of new data acquired tomorrow. It does *not,* however, guarantee that that will happen, or that no prediction of what will happen "if this goes on" will ever be right.

For that matter, even the fact that the elders never saw the wolf didn't prove that it wasn't already around, lurking in the woods just beyond the meadow.

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Maybe the little boy really was a pathological liar, just as they came to assume. Or maybe he was a very *bright* little boy with modern scientific equipment—or even just good old-fashioned tracking skills—and really knew the wolf was there long before it came out of the woods.

The *obvious* moral of the fable is that little boys who would cry wolf should not do so lightly, lest they be ignored when a wolf really comes along. But the second moral is no less important.

Those who hear the little boy, no matter how often he has been wrong in the past, must never lull themselves into the trap of assuming that the wolf is a mythical beast. ■

IN TIMES TO COME

● Some 20 years ago, when I was writing my first *Analog* stories, I did one in which both John Campbell and I thought I was portraying a culture so alien that folks like us wouldn't even recognize it as an advanced technological civilization until it was too late. What made it so alien? The technology was entirely biological, with engineered plants and animals instead of machines as we usually think of them. Less than ten years after that story appeared, I could already see hints that out own culture was starting down an evolutionary path toward that "unrecognizably alien" state of affairs.

What would a biology-based technology developed by humans in the near future look like? Naturally it would bear the imprint of the species that created it, as well as the other species that its creators used for "raw material." Thomas A. Easton has worked out quite a detailed, entertaining, and thought-provoking picture of one such future that might develop here. You've had a small taste of it in his short story "When Life Hands You a Lemming . . ." but there's much more to it than that. Beginning next month you can see the big picture, and what it does to some of the people living in it, in his three-part serial *Sparrowhawk,* ushered in by a dramatic cover by Nicholas Jainschigg.

Our October issue will also offer stories by Alexis Gilliland, Paula Robinson, and Kevin O'Donnell, Jr., plus another of Martyn J. Fogg's mind-tickling articles of astronomical speculation, this one on "Stellifying Jupiter."

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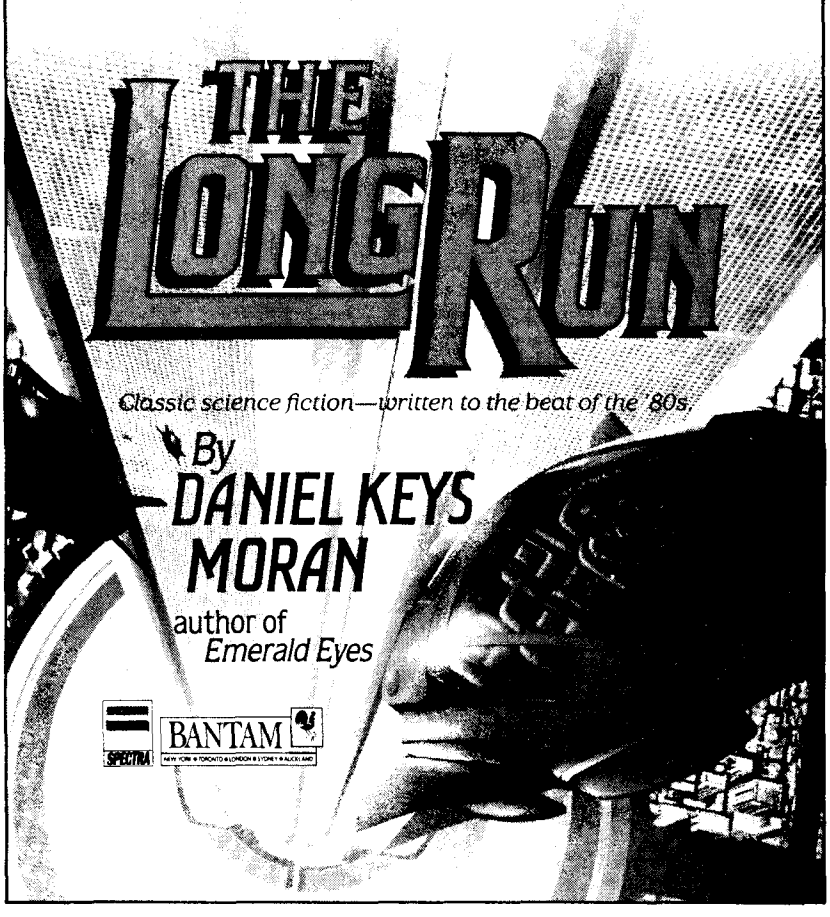

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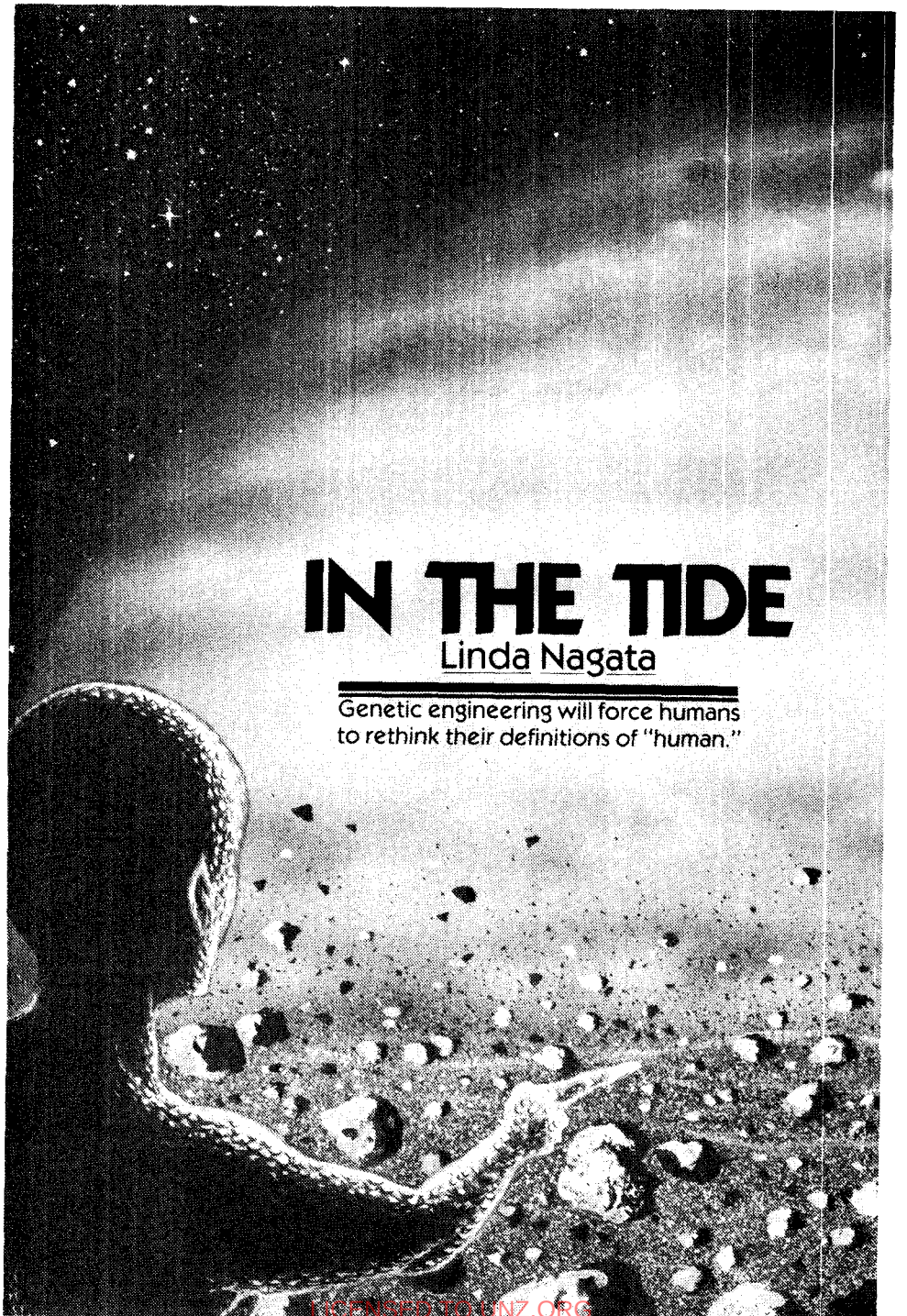

IN THE TIDE

Linda Nagata

Genetic engineering will force humans to rethink their definitions of "human."

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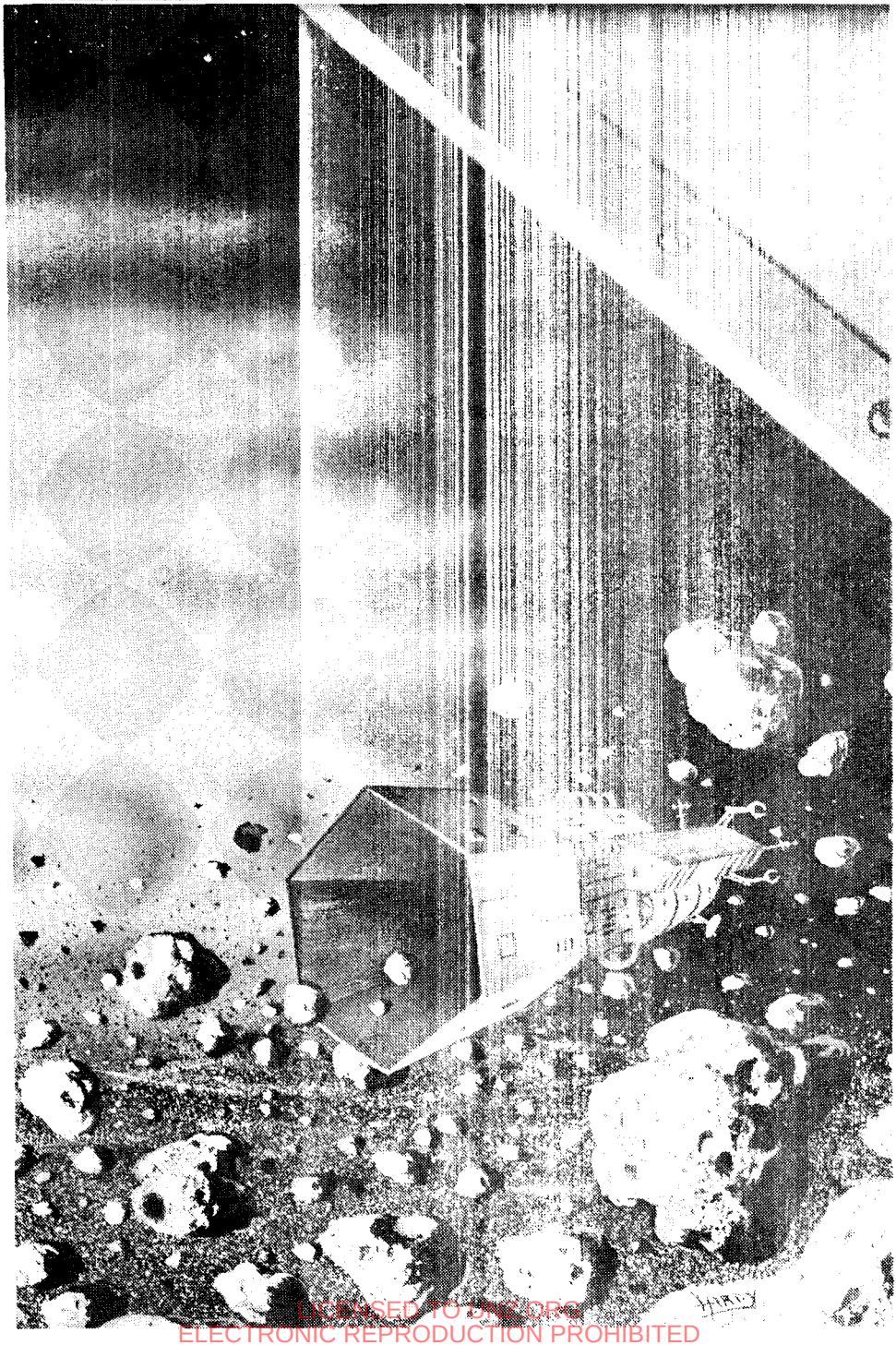

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A curt summons brought me running to the primary control room. I arrived to find the Commonwealth Police at our doorstep. In their pockets huddled the System's grandest Makers, a plague of molecular machines poised to invade our rogue station should we refuse to cooperate with their commands. I gazed in dismay at a projection of their ship: malevolent black cruiser marked with the dancing Chinese characters I knew so well. Never had I expected to see that lethal signature so far beyond the borders of the Commonwealth. I looked to our leader, Dahlia Ivanov, anarchist, owner of our station and inventor-extraordinary, seated like a queen on a dais at the control room's far end. One hundred sixty kilograms of billowing, low-gravity flesh should not be graceful. Dahlia defied that diction. With an elegant hand she fingered her single braid of thick orange hair as she awaited my assessment.

"Whatever you have to do, don't let them aboard," I warned. "Don't even let them dock. We're contaminated with a thousand illegal molecules. If the police scent that they'll terminate this complex and—" *Every one of you.* I bowed my head. "Please forgive me. If I'd suspected they'd pursue me as far as Saturn system, I never would have imposed on you."

Dahlia snorted. "Oh, Aron dear, do stop moaning. And don't jump to conclusions. I've summoned you for advice, not as a sacrifice. The police don't even know we have a deserter aboard."

Deserter. A cruel word, yet undeniably true. I'd been drafted into the police at an early age, having been foolish enough to display a youthful talent in molecular engineering. Finding police discipline a bit restrictive, I'd parted company with the service—a bit earlier than the legal niceties allowed. I drew a deep breath of relief. "All right. Then just who is it they pursue?"

"Indigo."

On a station that housed over six hundred malcontents and refugees, I doubted I could name six people lacking a criminal record. Yet if I had to try, Indigo would head the list. A Blue Series derivative human, Indigo had abandoned the company of her birth to work a rogue station bound for Pluto. "Indigo? What—?"

"Indigo, nothing. *We* owe them a debt for her services this past year. Now Aron, from your experience in the police, how much delay will be tolerated before the station is seized?"

"The station seized?" I asked blankly.

"Yes, dear. Debt is a criminal offense in the Commonwealth."

"I know that! But we're not in the Commonwealth."

"Some issues transcend legal boundaries. How much time do you estimate we'll have to prepare our escape?"

"Escape? We can't go anywhere. South station's still under construction." The ship that had brought us to Saturn system we now called north station. We'd tethered it to an asteroid (hauled on a long cable all the way from Jupiter) and spun the whole affair to give us gravity while we constructed south station from scratch—a second ship to house our expanding population. When south station was complete, the tether would be cut and the two ships would launch separately for Neptune. But that was more than two months

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away. I reminded Dahlia of this. "Two months is no better than a year. The police won't wait two days if they think they've found their quarry. And even if we were ready to launch today, we couldn't outrun their guns."

"He's right, you know," a calm contralto voice observed.

And so I was. Though as I recognized her voice, I suddenly wished I'd been less right and more gallant. I turned, as the only derivative human aboard our rogue station entered the control room. Indigo: cool and clever, smooth and hard. Distant. And utterly beautiful. She shrugged, a full-body gesture that ran like a wave through the shimmering, shining platelets of gold and blue that were her skin. Her armor. Her sequined birthday suit designed to protect her from the cold and vacuum of Outside. "Aron is right," she said again, stroking her golden kisheer, the living respirator that lay like a cowl across her throat while she breathed the air of the station. "I won't put you all at risk. I'll go back with them, if it comes to that."

"You will not!" My shout surprised even me. "Uh, what I mean . . ." I stammered, "is—"

In the three-quarter gee pull of the station, she turned slowly towards me, and once again I felt nothing but admiration for her designers. Certainly, they'd been esthetes. Their care could be seen in every aspect of Indigo, from her tiny, decorous breasts, the erect nipples visible beneath a teasing layer of armored skin;

to her spidery hands, graced with fingers so long, they ought to have tangled but somehow never did;

to her feet: twice as long as nature intended, with opposable toes that could purchase a solid grip on any handhold. Yet never awkward. Their length gave her a long, rolling gait that only exaggerated her femininity.

As to her sexual abilities, I had only Dahlia's account that she remained human, though sterile. A subsidiary organ (scarcely visible because it too was finished in armored skin) protected her vulnerable parts from vacuum while modestly concealing the evidence of her private nature from my eyes. Nothing else was hidden. Indigo wore no clothes because she had no need of them. She was complete as she'd been made.

Suddenly conscious of my ill manners, my gaze fell. I was in love with our Indigo of course, but to what end? She'd shown me no favor, given no answer to my tentative advances. What could I read from that but a gentle "no"? To offer love where it's not wanted was an insult Indigo did not deserve. To pursue her further would mean a loss of face for both of us.

Sadly, the delicate manners of civilized places are not common on a rogue station. Other men had offered her sex in no uncertain terms. Many times on my construction shift, I'd heard the post-mortem dissection of some failed suit, and the ribald speculation on the reasons behind her choice of sexual isolation. To me the explanation seemed obvious: biology. Surely Indigo possessed a natural desire for her own kind. Why should she take a human companion?

Gathering up the scraps of my dignity, I tried to compose myself, saying, "I don't understand the problem, Indigo. Who's the claimant on this debt?"

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She looked at me . . . looked *through* me really, her graceful face locked forever in an expression of saintly contemplation. Who could say what emotions passed behind that unchangeable mask? She said: "My former company claims the debt—SunBelt Enterprises." Her gaze shifted to the projection of the approaching ship. "Technically, I can work anywhere I choose. But my employer has to pay royalties to SunBelt . . . for the genetic work that went into my design."

"Oh." That made a cold kind of sense. "Well then. Why don't we just pay them, and—"

Indigo's lips parted and she laughed, a sound high and sweet, though no smile interrupted the perfect blue smoothness of her face. "You don't know what SunBelt charges for my services."

"Yes, they're very jealous of their Blue Series," Dahlia said. "Terribly afraid some pirate like us will clone them."

"How much?" I asked, not sure I wanted to know.

Dahlia pursed her lips and stared thoughtfully at the ceiling. "Less charges for towing back to Jupiter, and— hmm, they might accept south station as payment."

"South station . . ?" Seven months of labor had gone into the construction of south station. "That's ridiculous." Nobody argued with me.

"You're acquainted with the defense structure of police cruisers, aren't you, Aron, dear?" Dahlia asked. "Perhaps you could manage to infect this ship with a flock of Makers, something that might play hard with their life support and weapons systems before self-destructing? Give them something to think about besides us?"

I stared at her in shock. "*Infect* their ship?" I had no doubt I could construct an appropriate molecular machine for any assault Dahlia might devise. I was less sure Dahlia understood how well the police were defended against such microscopic invaders by their own formidable Makers. "Absolutely not ever in the life of the Universe," I said. "It would be an act of suicide."

Dahlia frowned. Then she patted me on the shoulder. "That's all right, dear." Looking at Indigo, she shook her head sadly.

Indigo shrugged. "I'll go back with them. You can claim that you scooped me out of the Void, which is true enough, and that you were only waiting for SunBelt to come pick me up. That way you won't owe them a thing."

I must have looked hopelessly confused, because Dahlia turned to me in sympathy and explained: "Indigo was the victim of a construction accident in the Jovian system. A miscreant tug launched her towards the radiation belts. SunBelt executives saw no chance of rescuing her in time, so . . ." Dahlia shrugged.

I turned to Indigo. "They left you to die?" She looked through me in her usual disconcerting way, saying nothing. And of course I could read nothing from the set expression of her face. Even her eyes gave me no hint of her inner feelings. Deep-set, dark and with a gleam that was not-quite-human, they gazed at the world from behind smoked windows of organic "glass." Helplessly, I rounded on Dahlia. "*Do* some-

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thing! There must be something else we can trade!''

''Perhaps there is,'' Indigo said softly. ''If we want to risk it.'' I felt a chill stroll up my spine, a premonition tossed in my lap by some vexing twist in space/time. She said to Dahlia: ''Aron has discovered a mining ship marooned in Saturn's B ring. Three ships, in fact, all abandoned by their former owner—'' brittle humor crackled through her voice ''—SunBelt Enterprises, Inc. If we could bring one out—''

I groaned. I'd mentioned the ships two days ago in a shallow attempt to amuse her. I'd been playing with the station's optical telescope when she'd chanced to pass by. ''Take a look at this,'' I said, laying claim to her attention. Amidst a projection of Saturn's brightly colored rings wandered a tiny spot of shadow. ''That's a robotic mining ship once owned by SunBelt Enterprises—your former company, so I've heard?'' (I hadn't known her history then! How crass I must have sounded.) ''Look close, and you can see the company name printed on the spine of the ship.'' At least, if I squinted just right I *thought* I could make it out: SunBelt.

Indigo shook her head. ''You're imagining it. SunBelt doesn't mark their ships like that.''

''I'm *not*,'' I protested. But I couldn't prove the point. ''Anyway, this is one of three ships SunBelt designed to harvest volatiles in the belts. All three are still down there—abandoned—after a working life of . . . oh, five to ten minutes. They're derelicts now.''

''What happened?''

I smiled, pleased that I'd caught her interest. ''That's a mystery. Radio contact with the ships ended after the first few minutes. Satellite observation ultimately confirmed no activity. Repair pods were sent in, but those were never heard from again either. At the time there were protests about mining operations ruining the esthetic value of the rings. That was nineteen years ago.''

''Environmentalists?'' She spit the word with some distaste. That was her corporate background. Environmentalists traditionally played a hard and dirty game with the big industrial companies; sometimes company personnel found themselves employed in battle-zones.

I nodded. ''Apparently the activists poisoned the ring with a very talented strain of Makers—an *uncataloged* variety designed to infect and destroy the control centers of spacecraft.'' Possession of an uncataloged molecular machine is a capital crime in the Commonwealth . . . which is why our rogue station had sought the freedom of the outer worlds. ''The Maker's molecular structure is still unknown, because no probe has ever returned a sample of ring dust for analysis.''

Molecular structure is everything. Design the proper molecule and you'll have a microscopic servant capable of reassembling, cell by cell, a badly damaged human body, or of weaving carbon atoms into diamond fiber, or, with more destructive intent, disassembling the walls of an orbiting city into their component elements, exposing the inhabitants to hard vacuum.

Speed and scale preclude direct human control of these microscopic processes, so the responsibility falls to a sub-class of constructed molecules: the Makers.

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Makers are the molecular equivalent of programmable computers. Like viruses, they can cause millions of copies of themselves to be manufactured, and then proceed in invisible legions to carry out their programs. Unlike viruses, they can deliberately modify their instructions (and structures) when circumstances demand. The only defense against attack by a Maker is another Maker. Nineteen years ago, in a lightning-fast microscopic war, the Makers that polluted Saturn's rings had quashed the best defensive molecules SunBelt then possessed . . . but if Indigo had been impressed by that startling fact, she'd given no sign of it.

Now, with the Commonwealth Police bearing down upon us, I wondered what hope she saw in my tale of lost ships. I shook my head. "Indigo, you know we can't go down into the rings. The belts are poisoned with uncataloged Makers. Nobody comes out of there."

When Dahlia's eyes glinted orange, I knew I'd said exactly the wrong thing. "Our defensive Makers can neutralize any plague in the System," she insisted. "*Faster* than your police models." Her gaze shifted to Indigo. "If you want to do it, dear, I'm right behind you."

We told the police Indigo was on Tethys and would be returning on a heavily-laden ice freighter in two days' time. They politely agreed to await her arrival—though I suspected they experienced a mild disappointment over losing an opportunity to inspect our station. Meanwhile, we commandeered a tug that had come over from south station to resupply.

Fading odors of stale coffee and dried fish greeted us as we boarded. Someone's half-finished lunch clung Velcroed to the wall. Near the door, beneath a column of Chinese characters expressing hopes for good fortune, hung a tool belt, a cutting torch, and a net bag containing three rolls of half-meter wide silver tape—a highly visible adhesive used to mark construction sites. I shoved these into an empty locker while Indigo disposed of the trash. A few minutes later, we left the station behind.

"Indigo?"

"Yes, Aron?"

My hands closed in rage as an image of my beloved falling alone towards certain death in the radiation belts of Jupiter played in my mind. "SunBelt doesn't deserve you. *I* would never abandon you."

"Why . . . thank you, Aron."

I looked up at the catch in her voice, but her eyes told me nothing.

We were alone on the tug. When, despite my emphatic objections, Dahlia and Indigo agreed to this scheme, I was left with nothing to do but volunteer my services. I'd expected Dahlia to accompany us, but apparently she'd thought better of it. I had to admire her for that.

"There it is," Indigo said. I looked out the viewport to see Saturn, its yellow face marred by a white spiral of storm winds. The southern hemisphere of the planet rose like a great, dull sun out of the plain of the rings. And there indeed, roaming towards sunset, was the mining ship we hoped to salvage.

Our approach would not be simple. Saturn's moons combined with their parent to create a complex gravitational field in the belt, generating braids and streams and waves of force that contin-

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uously churned the material in the rings. I left the problem in Indigo's capable hands, and turned once again to the diagnostic kit Dahlia had given me. Waferthin and no larger than my palm, the kit was a miniature laboratory capable of analyzing the structure of any active molecules we might encounter in the ring and of devising a Maker to neutralize them. Dahlia assured us it couldn't be defeated by a strain of Makers nearly twenty years obsolete.

Sometime later a dreadful *ping!* rang through the tug's hull. "Ice fragment," Indigo said shortly. "The ship will be singing before long."

So right, as usual. As we descended into the ring, we dodged the largest of the drifting icebergs: dangerous obstacles tens of meters across. But the myriad smaller chunks and particles of ice we simply pushed aside—or obliterated. A metaphor comes to mind: hailstorm. Soon, the ship rang so loudly under the barrage that conversation became impossible. Indigo shrugged the golden cowl of her kisheer up over her ears to seal them from the noise.

Seventeen minutes after the initial ping, a final nudge of deceleration sent me leaning against my harness. The hailstorm had subsided as the tug closed on ring velocity; now it spoke in a faint susurration, like secrets whispered between decks. I stared out the viewport. Ahead of us, a following sun had turned the ring dust into a fine-grained fog. The miner was barely visible: it seemed more like a dark scar on my retina than a solid object actually embedded in that field of white.

I unstrapped and drifted from my chair. The time had come to collect a sample of ring dust. My suit hung in a locker. I removed it and shook it out. It was the best I could afford to buy during my hurried departure from the Commonwealth: light and slim, with a passive thermal system powered by body heat. As I pulled it on, molecular machines in the fabric shaped it to fit perfectly to my body. They also held it rigid against pressure. I could move only because microscopic sensors woven throughout the suit instructed the fabric to yield.

I retrieved the diagnostic kit, pulled on the helmet, then turned to key open the shield door. The interior panel slid aside to reveal the gelatinous lock.

Rumor reports that Dahlia designed the lock on a day when she was exasperated with all things mechanical. When I first encountered it, it nearly scared the—

But pardon me. I find my metaphors grow increasingly crude the farther I travel from Sol. Suffice to say I was not at all comfortable with the idea of a gel-like semi-permeable membrane as the only barrier between me and hard vacuum. Time modifies prejudice. Now the slow cycling of standard locks seems a tedious process.

I turned to wave to Indigo, then plunged into the lock. Where the dense gel wouldn't yield to the uniform pressure of cabin air pushing outwards on its surface, it gave easily before the isolated force I exerted as I pulled hard against the hand-grips. For a moment I was a swimmer seeking the far side of a pool of gelatin. Then my helmeted head emerged Outside. I clipped my safety line to the nearest mooring and

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swung out of the way while the membrane self-sealed behind me.

Random static generated by the electrical currents in the ring crackled in my helmet. When I released my handhold, minute tidal forces began to draw me gradually, gradually away from the ship. I checked the kit. Green lights glowed reassuringly on its face. A sigh of relief escaped me. I'd had real doubts about our defensive Makers, but it looked like they'd keep the environmentalist's poison from savaging us. I hit the intake.

Microscopic particles of dust drift everywhere in the ring, so it was no surprise when the kit immediately recorded a hit. A blue light winked on, indicating the tiny chemical laboratory had undertaken an analysis. And then it winked out. The kit's entire face went black. No green lights. No red. Nothing. I checked the on/off toggle. Jiggled it a few times. Nothing.

"Indigo." Some odd corner of my mind noted with pride that I managed to screen most of the panic from my voice. "Indigo, the poison's infected the kit." I waited a moment for her to answer. "Indigo?"

Silence filled my helmet, undisturbed even by the crackle of static. Realization swept like a thermal pulse across my brain. *The radio's been disabled!*

What had become of our defenses? Was nothing safe? For a horrible moment I imagined my suit collapsing around me as voracious Makers rearranged its molecular structure. With trembling hands I pulled on the tether, sure that it would disintegrate under pressure. It held, solid as ever, and I quickly hauled myself back to the silent tug.

What could I do? Our defensive Makers were worthless. If I pushed my way back through the lock, I would infect the ship instantly. If I stayed here . . .

My gaze strayed to the robotic miner, now only a few hundred meters away. The instruments aboard that ship had never been exposed to vacuum. Yet in minutes the ring poison had penetrated the ship's seals and killed it.

So it was only a matter of time until the infection found its way aboard the tug.

Another thought occurred to me then. While the air I breathed was recycled through a biological filter, that filter received nutrients through the actions of a delicate pump. If the pump failed, then nutrients could no longer reach the filter. The biological membrane would die within a few short hours . . . and I would rapidly follow.

I flung myself through the lock, grabbing blindly at the handholds. There might still be a chance to escape the rings. If we burned all our fuel now, we could pick up enough velocity to throw ourselves clear. We wouldn't need to control the tug after that. Dahlia could pluck us out of the Void. . . .

"Indigo!" I shouted, as I emerged on the other side. I unsealed my helmet and opened it a crack. "Indigo! We've got to get out of here before it's—"

Too late. The caterwauling of a half dozen alarms assaulted my ears. The console glowed cherry-red with warnings. Orange emergency lights bathed the cabin in an eerie glow. "Total system failure," Indigo informed me, shouting to be heard over the din. "The

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damn defensive Makers *failed!*'' Indigo never swore. We must be in deep, deep trouble.

I watched her helplessly as she rummaged through the equipment lockers. ''Who's responsible for this tug?'' she snapped. ''Why isn't the equipment where it's supposed to be? Ahh . . .''

She retrieved the small cutting torch I'd stashed in a locker and test-fired it at a bulkhead. ''Hey!'' I shouted, as the beam burned a tiny hole through the wall.

There was a *pop!* then a high-pitched whistle as precious air streamed into the void. Slapping the handgrip, she added, ''It's lo-tech. No artificial intelligence in its processor.'' The whistle rose in pitch, then cut off abruptly as repair molecules in the ship's skin quickly healed the wound.

Invented intelligence did seem to be the target of the uncataloged Makers. From the ship's electronic nervous system, to our ill-fated defensive molecules, everything capable of artificial thought had been neutralized. The simpler molecular machines such as those in the fabric of my suit and in the tug's wall, which responded mechanically to appropriate stimuli, remained intact. So did the two nodes of natural intelligence aboard ship, for which I was truly grateful.

''We have to tether the tug to the miner,'' Indigo announced. ''Then we can use our difference in velocity to swing around and launch ourselves out of the ring.''

My eyes opened wide. I'd seen the miner. And our velocities weren't that different. ''We're going too slow,'' I objected. ''And even if it could work, *I don't have time!*'' I told her about the pump that nourished my rebreather. ''It *does* have computer components. It's going to fail . . . if it hasn't already.''

Indigo had been in the act of fastening a tool kit around her waist. Now she froze. ''A pump? The system's not organic?''

''Not completely. The maintenance is mechanical.'' Suddenly I sensed how false her former confidence had been.

''My blood nourishes the kisheer,'' she whispered. ''I thought . . .'' Her gaze fixed on an infinite point. ''Aron, I just don't know what else we can do without help from above.'' One by one the tug's alarms were failing, as the poison penetrated deeper into ship's systems. The console had gone dark. ''Damn, we need the radio!''

I shook my head. ''Even that wouldn't help. We can't ask Dahlia to send another tug—''

She interrupted me with a curt gesture. ''We can! If it doesn't come all the way into the rings. . . .''

Hope leapt in my throat. ''You have an idea?''

She sighed. ''It's no good if we can't communicate it to Dahlia.''

''Tell me! Tell me, and we'll find a way to talk to the station. I promise.''

When compared to their breadth, the rings are the thinnest objects in the Solar System. Clean space, unpolluted by ring poisons, where rescue vehicles could operate without difficulty, waited less than a kilometer away. As Indigo sketched her plan, I realized she could get us there.

Trailing the station in its orbit around

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Saturn lay the husk of the little asteroid whose innards had been converted into south station. Following in the same orbit, neatly coiled and stored in a pod, came the hundred klick cable that had served as a tow rope when the asteroid was yanked from the stockpile of a mining company doing business in Jovian orbit. "That cable can serve as a tether," Indigo explained. "A small engine can carry the free end down to us. We'll fix it to the miner, and—" Her hands made a blooming gesture, full of expectations. . . .

. . . and hope flowered in my mind. "Ahh! Of course! A tug or two on the other end and we escape along with the prize. Can it be done?"

"Why not? With working tugs as a counterweight, we can spin the whole system. Ninety degrees through the first rotation and we'll be well clear of the rings."

I grinned. Like an analog of the station on a huge scale, we could use Saturn's tidal forces to construct a temporary elevator out of the rings. As the giant contraption turned, we'd be lifted to life. Filled with the dizzying joy only a reprieve from certain death can bring, I grabbed up Indigo's hand in mine, and kissed it. Her skin felt warm against my lips. Glassy smooth and warm, despite the scales of her bejeweled hide. I looked up in mild surprise.

"We still have to find a way to get word to Dahlia," she cautioned, stroking my cheek with an enchanting tenderness that confused the words in my mouth and left me warm and flustered. With feather-light fingers she caressed my ear, brushed my neck, blessed my lips. And the sun filled me. A blinding thrust of heat that seared my brain and burned it clean. Without a thought, I slipped my arms about her waist, pressed my cheek against her belly. Slowly, dreamily, I let my lips wander across her glassy skin. In that moment, I cared not at all about the rings, the Makers, or our own dire circumstances. Fortunately, Indigo possessed more sense than I. "Aron." She stopped me with two fingers placed against my lips. "We'll have to get started soon."

I craned my head back to see her face, my arms still locked around her. She didn't seem to mind my advances — truly—or I wouldn't have continued. Gratefully, I pressed my cheek once more against her belly . . . and felt an answering pressure as her legs encircled mine. "Time to go," she whispered, and gently, she disentangled herself. Moving swiftly, she retrieved my helmet from the corner where it had drifted and helped me fit it once again to my suit, all the while sketching the details of her plan. I listened absently.

"Questions?" she asked, as she concluded.

"What? No. None." I longed to reach out and touch her face, taste her breasts. But our relationship remained unclear. Had I dishonored her with my affection? Had I dishonored myself? Or were we lovers now? I couldn't tell. And I had to know! Courtship should be a subtle thing, but suddenly there was no time. "Wait, there is one question. Indigo, could you love a fully human man?"

She froze. "You ask me that? Do you care?"

I blinked. "Of course I care! I love you!"

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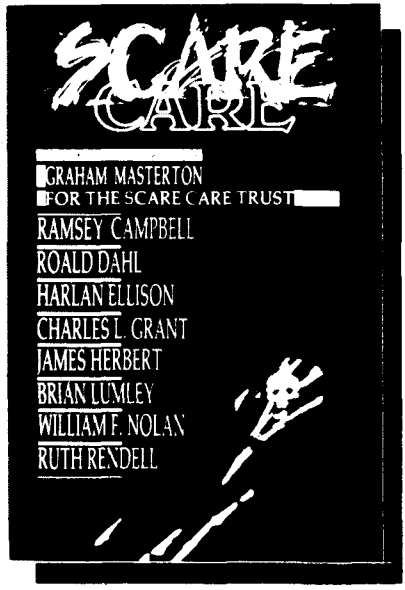

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Though her face remained impassive, anger sparked her voice. "Do you? I never noticed a sign of *that,* though I looked. But then, who could read *you?* So formal and so reserved. You wear your civil manners like a mask!" And with that she slammed my helmet closed and sealed it, locking me in a cage of silence. I was far too astonished to object.

Turning half away from me, she jerked her kisheer up over her mouth and nose. The living organ immediately melded with the tissue of her respiratory system, providing her with oxygen while she returned to it the carbon dioxide it needed to survive. Settled in its active position, it looked like a respirator draped in a gold kerchief. Glaring at me once through her windowed eyes, she turned and dove through the lock.

I followed at a slower pace. Already the air in my suit tasted hot and thick with CO_2 as the efficiency of the biofilter began to decline. I swallowed hard. Another few hours without a nutrient bath to nourish the organics, and the air would be too fetid to breathe.

Following Indigo's instructions, I used the cutting torch to free a tow cable that had been locked down in its cradle at the stern of the tug. Indigo took the free end. Coiling herself against the side of the tug, she sprang backwards using every bit of force her long legs could muster. The cable paid out behind her. Hooking the torch to my belt, I watched her go.

Our path had crossed the miner's orbit since my first foray Outside. Now the derelict ship lay some two hundred meters out and to our stern. Indigo almost missed it.

Briefly, I saw her silhouetted against the huge, dark cave of the intake throat, a tiny doll cast adrift. Then she was past it, moving at an angle to the hull, still three meters inside the miner's orbit. The receding sunlight glinted off her blue-gold skin. I held my breath. And slowly, I saw the gap that separated her from our prize begin to close.

SunBelt Enterprises had invested heavily in this mining machine. It loomed like a menacing storm in the diffuse white light of the rings, three times the length of north station and twice as broad. Indigo swept past nearly the full length of the hull before she finally found a handhole. Slowly, she began to climb across the rust-colored metal, a lonely figure marooned on an island in a strange, dusty sea of powder and ice. As I watched her, I wondered: *could she love me?* That she might had left me both flushed with joy and desperately afraid I might fail her. I checked the tow cable—still slack, as it would be for sometime to come while the two vessels drifted gradually apart—then I returned alone to the tug's tiny cabin and set about trying to rewire the radio.

The cabin air grew slowly foul around me as I worked. Odd thoughts wandered through my brain, pessimistic threads that finally wound together into a single question: were we being irresponsible in our attempt to escape the rings? Given the Makers's fierce appetite for machine intelligence, what might the consequences be if even a single molecule escaped sterilization . . . ? But my desire to live overrode my conscience and

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I determined to keep silent on this point. I've never claimed to be a moral man.

In the end, my attempt to rebuild the radio proved futile. I couldn't coax even one tiny circuit back to life. My head ached from the effort, and finally, I gave it up, exhausted.

The time had come to go Outside and find Indigo. I sealed my helmet. And immediately, I realized I'd made a terrible mistake. Without my breath to circulate air, the decay in the organic filter had accelerated. It felt as if I were breathing through a hot wad of insulation. Nothing to be done about it now. I crawled through the lock, to find that our orbit had brought us around to Saturn's night.

A few bright stars glinted through the ring dust. A roving moon cast a little light. In its thin beams I saw Indigo working her way back across the now-taut tow rope. But it was another sight that drew my eye. During the past hours, the tug had swung around the miner, until now I could see a different side of the huge ship.

Smug! That's how I felt when I saw the proof that I was a better observer than Indigo. For emblazoned in mottled yellow roman letters across the miner's back was the word SUNBELT, just as I'd described it to her two days ago when I'd coaxed her to join me at the station's telescope. In smaller script following, I mentally translated the Chinese characters: *Saturn Division, SunBelt Enterprises, Inc.* This was our way out! If I could read those giant letters from the station's altitude, then Dahlia could, too. And I knew exactly how to overwrite a brief message of my own, two simple characters that would explain our situation.

I whooped, wasting precious oxygen, then turned and dove back through the lock just as Indigo reached the tug. Yanking off my helmet, I thankfully breathed of foul air. When Indigo emerged behind me, I turned around and kissed her cheek. "The rolls of tape!" I shouted. "We can *write* a message to Dahlia."

She spit out her kisheer. "Aron, are you all right? The air in here. . ."

"I know, I know. Keep moving, or you'll be breathing your own exhalations." I yanked open a locker and grabbed the net bag that held the half-meter wide marking tape. After removing a tangled wad of multi-colored wires, several bits of broken plastic and a piece of torn packing foam, I held the bag up to Indigo in triumph. "We can *write* a message to Dahlia. We're going to make it!"

It was *not* lack of oxygen. I swear I saw her smile. After sealing up my suit, we hurried through the lock, and together began the long, hand-over-hand journey across the tow rope.

Black shadows had stolen across the periphery of my vision by the time we reached the miner. My senses seemed to blur as my oxygen-starved brain stumbled over simple thoughts. Through the confusion, I felt Indigo take my arm. She pulled me with her as she worked her way around the miner, and finally, she pointed to a broad, flat surface.

I stared at the site, wondering what significance it had for her. Finally, she tugged at the net bag that I carried on my waist. *Ahhh . . . !*

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Quickly I tethered myself to a handhold, then pulled out a roll of tape, searching in the faint light for the tab that should mark its beginning. A flush of fear drove through my veins when I couldn't find the tab. Then it was there, beneath my trembling fingers. One half of it had been torn away. I yanked at the remaining piece. It shattered like a fragile leaf of glass! I screamed in frustration. Then, pulling a screwdriver from my belt, I began to pry at the tape's end. A half-dozen silver chips broke off, like flecks of old paint chiseled from a wall. "*No!*" I whispered. "Please, no." I tried again, but I couldn't free the end. The tape had fused! Somehow the adhesive had leaked through its protective backing, sealing the roll, layer after layer, into a solid cylinder. Cold washed over me as I remembered the motley collection of debris I'd discarded from the bag—scrap wire, useless packing. It was all clear to me now. What I held was rubbish, trash, the contents of a garbage bag! I hurled the roll in a rage.

Startled, Indigo twisted to catch it, missed, then turned and snatched the bag away from me. Hurriedly she removed a second roll, examined it and embarked upon the same awful process of discovery I'd just endured. When she tossed the roll over her shoulder, I knew it was all up for us. Still, I waited with stubborn hope while she examined the last roll of tape. That too, she eventually cast away. It tumbled end-over-end, sparkling in the moonlight until it disappeared into the Void.

I felt a touch against my shoulder and turned to see Indigo. Gently she embraced me, her head against my shoulder, her legs wrapped around mine. The torch, still tethered to my belt, she brushed aside. I held her tight, while inside me, rage burned. *I couldn't let her die!*

But what could I do? My muzzy brain offered no solution.

Off beyond Indigo's shoulder a tiny moon was falling through its orbit. I watched it. How fast it seemed to move! When a blue flame burst from its end, I started in surprise. A spacecraft? Observing us? How close could it be? The fire disappeared, but not before it had ignited a vision in my brain. Could I offer up a flame in return? My hand sought out the torch. The instrument's invisible beam could not be used as a signal, but perhaps . . .

Indigo must have sensed that something had changed, because she pushed away from me. With my arms free, I wrested the torch from my belt and ignited it. I was laughing, I think. At least I remember strange bubbles of humor fizzing through my brain. Squeezing my eyes shut, I summoned a vision of the Chinese characters I had to draw. Then, in huge zig-zag lines of heat, I began to scribe a message in the miner's skin: 人(human) joined on a long, long rope to 天(heaven).

Indigo tells me a rocket came on a tongue of fire, and fused itself in an explosive weld to the miner's back, the tether trailing behind it for a hundred kilometers. I have no recollection of the event myself. I didn't live to see it.

"Oh yes, it was a close thing for you, Aron, dear," Dahlia confirmed, not for the first time. She looked across my

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hospital bed at Indigo, who sat on the other side. Then shaking her head, she rapped her soft fist against my skull. "There was *so* much damage in here. I do hope we put things right."

I'd spent the thirty-seven days since my death in coma, while molecular machines completed repairs on my damaged cells. In that time my voice had grown rusty from lack of use. "But did you sell the miner?" I croaked.

"Oh, yes, dear. We'll be safely off to Neptune by the time the police think to trouble us again."

I turned to Indigo, and wondered if it would do to offer my hand. She seemed to sense my uncertainty, for she settled the problem by trading me a kiss. Her mouth shocked me: hot and rough, lined with a thousand little tongues that trembled like beating cilia. I responded as any gentleman would—eagerly—while wondering what other secrets her body held. I fervently hoped I'd be given the opportunity to find out. Yet when our lips finally parted, a question lay between us. "Does SunBelt mean nothing to you, Indigo? Can you live, never seeing another of your kind?"

Behind me Dahlia chuckled, while Indigo looked typically inscrutable. "Blue Series derivatives have been selected for body form," Dahlia said. "Very little work has been done on their psychology. Indigo—and every other Blue—is as attracted to original humans as any of their ancestors ever were. I'm afraid *you're* the one with the unusual sexual preference, Aron."

Can I be blamed for a rapid change of subject? Sheepishly, I asked, "How did you finally sterilize the miner?"

"We didn't," Indigo said.

"What?" I sat up in shock.

"Tut, tut, Aron," Dahlia said. "Don't look at us like that! There was no *need* to sterilize the miner. An environmentalist designed the ring Makers, remember? Checks were built into the system to forestall a plague. As soon as the little monsters are removed from the ring gravitational fields, they dissociate."

I frowned. "So you never did get to analyze them?"

An orange light seemed to ignite in Dahlia's eyes. "No. The clever little bastards. But don't you worry, dear! I'll learn. I will learn."

I didn't doubt it.

Dahlia left then, but Indigo stayed. "I suppose this hospital is a fine place," I said, turning to her. "But when am I to be released?"

"Tomorrow." She took my hand. "But we don't have to wait that long."

I smiled. Suddenly, we understood each other perfectly. "No," I agreed. "We don't."

She kissed me again, and in a soft voice told me what would please her. I did the best I could. Caught up in the tide of her affection, I was a happy man. ■

● "Common sense" for each of us consists of what we learned prior to age sixteen.

Albert Einstein
submitted by John Hradsky

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Jay Kay Klein's biolog

Linda Nagata sees nothing specially unusual about living 3,000 feet up the side of a two-mile-high volcano. From this vantage point on Haleakala in Maui she could see clear to the Pacific, if it weren't for the Australian tree planted across the road. Writing is done in a bedroom corner equipped with a computer, much more comfortable than outside, where sometimes in the afternoon it is absolutely freezing at 65°F.

The Haleakala National Park starts a thousand feet higher, and husband Ron works in a building at 7,000 feet, where he is the chief of resources management, trying to preserve the natural environment. This includes keeping goats and pigs away, and trapping mongooses. Linda worked there for a while, too, fielding tourist questions at an information desk. ("Which way to the top of the volcano?" "Which way to the bathroom?") Linda is starting to study Japanese in the hope of getting enough ahead of the current awful exchange rate for them to be able to hike together through the Japanese countryside and small villages.

Born in San Diego, she reached Hawaii at age ten, when the civil service office of the Navy transferred her father to Oahu. They lived for some years in a beach house at the end of a private road. There, storms would send waves through the yard and spray against the picture window. She started reading SF around that time, following the path of her father and elder sister. At the University of Hawaii, she took a B.A. in zoology, a subject that has helped immensely in her writing. Though her father decided he had reached paradise in Hawaii, and stayed until retirement, Linda warns that mainlanders thinking of doing the same had better first check out the cost of living--sky-high prices for real estate and groceries. Most available jobs are not in the executive class, and cultural differences can leave a *haole* feeling lost and a long, long way from home.

Her first story appeared in *Analog*, April, 1987, with two more following, and there's a novel just about finished now. As might be expected from a zoologist, Linda is thoughtful about where we are going as a species, and if we survive at all, what will we look like at increasingly distant points in time. Unlike the rest of the world, Hawaii gives a glimpse into a future where people of different backgrounds may meld ethnically and racially into a new variety. Unlike nearly every other SF writer outside Japan, she has extrapolated population densities into future stories where the dominant presence in space is Asian. Names and ethnic heritages are jumbled.

Linda's novel is a vision of the future where nanotechnology offers the ability to alter the genetic code and everyone and anything could be refashioned for the best, if only one knew what was best. And human beings being what they are, repressive religious tenets forbid the exploration of genetic engineering and exercise of molecular biology. Until someone decides to upset the social applecart. At the rate we're advancing forward and sideways at the same time, that's not at all implausible. ■

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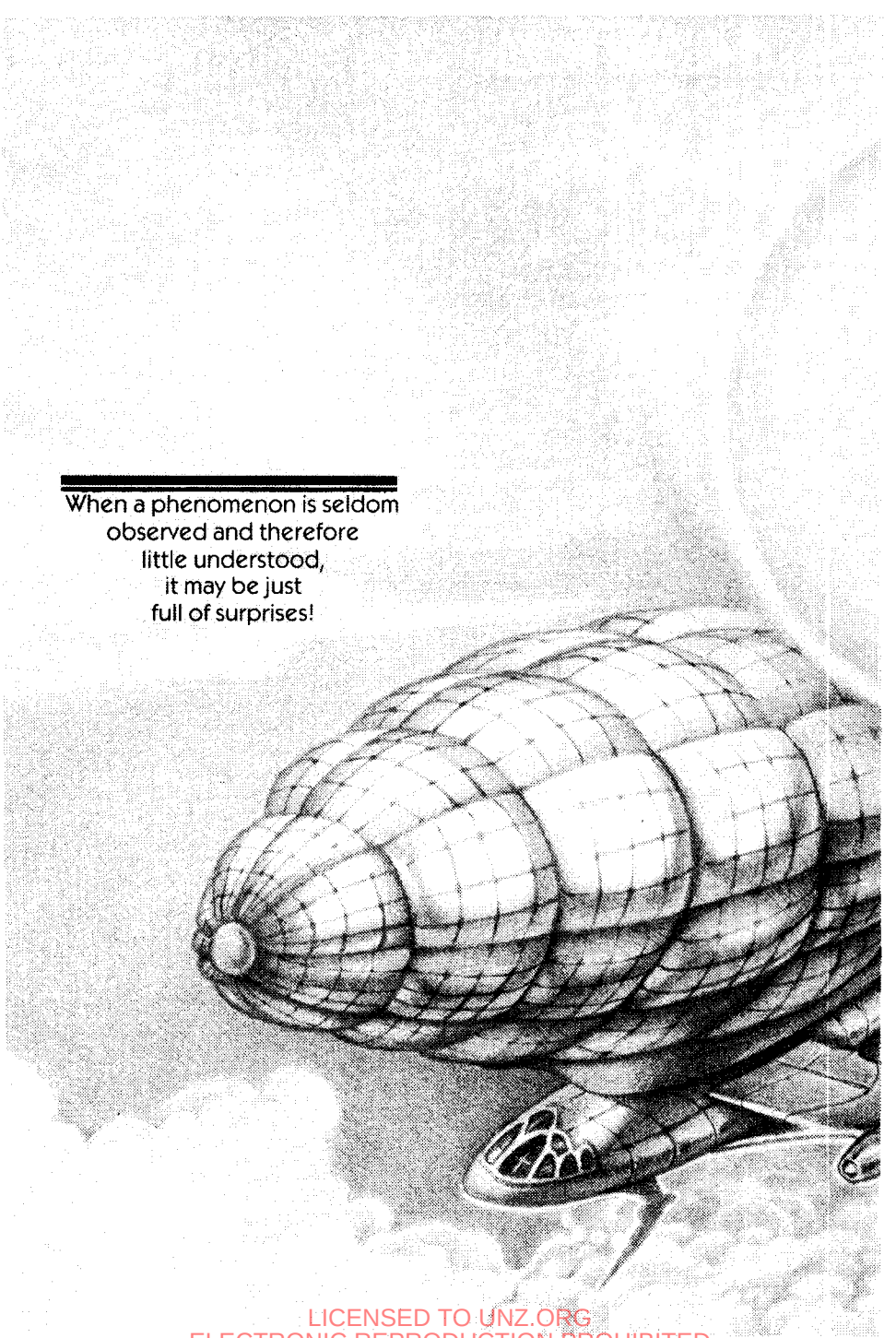
When a phenomenon is seldom
observed and therefore
little understood,
it may be just
full of surprises!



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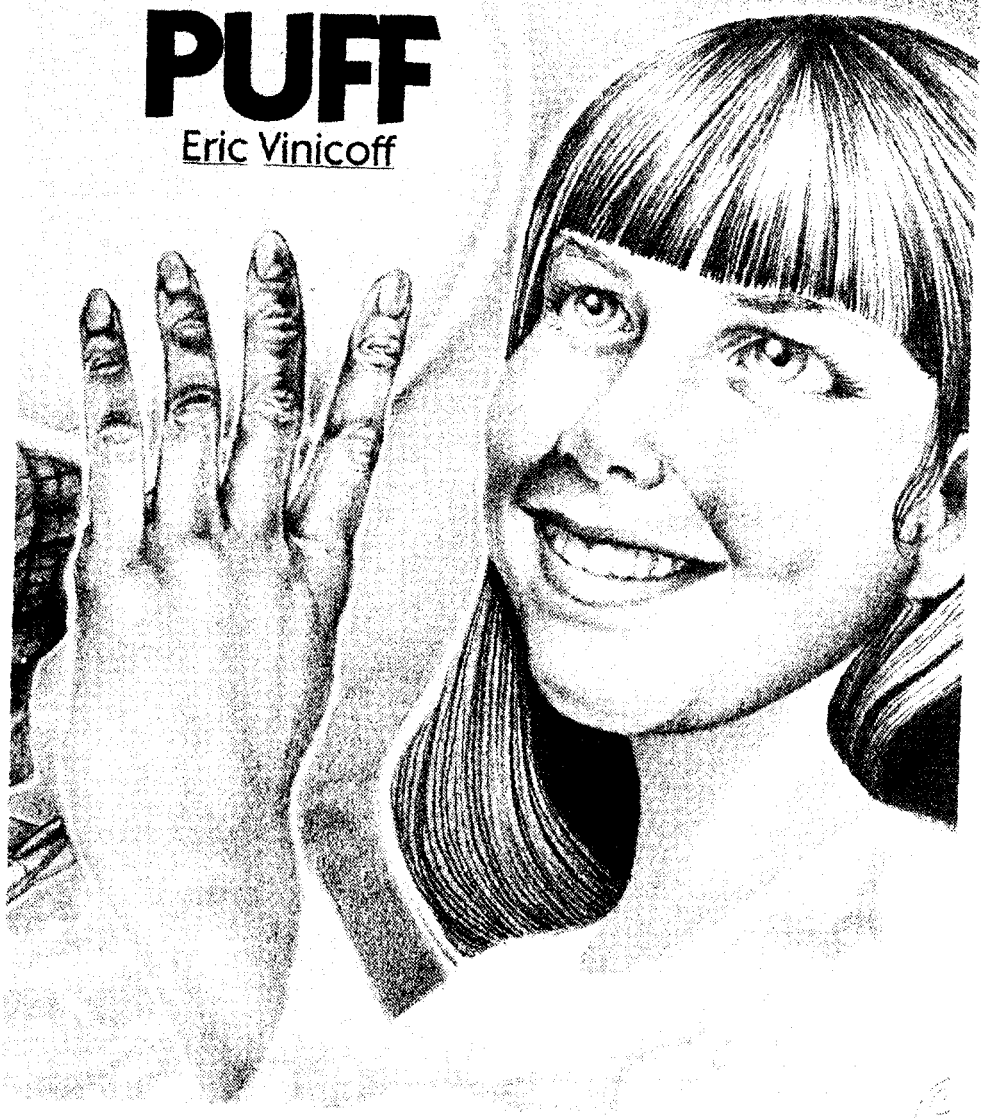

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Dan Muscatine peered out the *Condor*'s cockpit windscreen at the endless plain of bright fissured ice, and wondered how Greenland had come by its name.

He automatically tended the flight controls as he wondered, keeping the *Condor* into the wind which was stiffer than he liked. Its nose was moored to the pole that Doris Wilshire and John Loving had planted deep in the ice, while it sat (and slid) on its landing pads.

Like all bagmen Dan hated the surface. There was too much weather, and of course the killzone. Six decades after the War had rendered the surface uninhabitable, the radiation level was still high enough to fatally punish a mistake.

Two hundred yards beyond the mooring pole the portable drilling rig looked like a miniature oil derrick. A pair of figures in bulky outside suits were keeping it running. The thermal drill head had reached ice frozen before the War, and had melted a pocket of it. The uncontaminated water was being pumped through a flexpipe to the *Condor,* where it was filtered and stored in the tank which filled most of the cargo hold. It was destined for Calgary Four. Windriders recycled their water as much as possible, but there were inevitable losses which had to be replaced.

"Doris here, Dan," the com speaker crackled. "All green at our end. How much more tank to fill?"

Dan checked his computer screen. "Back-line in forty seconds," he said into his mike. "Stand by on the manual cutoff, just in case."

"I'm goosing it now."

But the pump shut down and the valves sealed the instant the tank was filled. "We've got what we came for," he told Doris. "Pack up, and we can go home."

"Sounds good to us. This place is too hot and too cold."

Doris and John dismantled the rig, rolled up the flexpipe and power cable, and loaded everything into the hold. Dan pumped tanked helium into more cells of the honeycomb bag, keeping the *Condor*'s buoyancy close to neutral. Noises from astern told him that his two crewmates were going through decon and taking off their suits. A few minutes later the cockpit door opened, and Doris and John settled into the seats flanking his.

"All secure in the hold," Doris reported to Dan as she activated the navigation board. "Take us out on heading one eight four, and climb to eleven thousand feet. I'll find the course as soon as I get a WeatherNet and position/course update from Calgary."

"I've heard of blimps where the captain gets to give the orders," Dan replied dryly. "Ready to cast off, John?"

John looked up from the co-pilot's set of controls and displays. "All green here. Remember, we'll wallow like a pig with so much weight."

Dan sighed. "Maybe you two would like to do this without me?"

"Sensitive, isn't he?" Doris said to John. Everyone laughed.

The three of them prepared for takeoff with the smooth skill of a veteran blimp crew, which they were. John freed and reeled in the mooring line. Dan swiveled the four motor gondolas on the sides of the car upward. The photovoltaic skin on the upper half of the bag was feeding plenty of current to the batteries, so Dan

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revved the motors. The *Condor* climbed smartly away from the ice-covered plain.

There were a few rough minutes as the *Condor* plowed through some near-surface turbulence. When Dan had a comfortable amount of sky under him, he dropped the blimp's nose to a less stressful angle. Climbing above the kill-zone, he flew into the wind to decon the hull, and flushed the hold and airlock. Then he brought the blimp around to Doris's preliminary course.

Switching to auto-con, he stretched his muscles, which had been tensed for five straight hours since the landing. The sky was bright blue, with clouds gathering in the distance. The noontime Sun hung well south of zenith. The cockpit was quiet except for the muted growl of the motors.

John raised Calgary Four, and Dan made his report. The windrider town of Calgary was three hundred miles south, sailing west at thirty-two thousand feet. When the weather, position, and course data came in, Doris went back to work. A few minutes later she told Dan, "Course plotted. We're going to have to swing around that weather up ahead."

"Damn. I promised Janice I'd be home for supper." But Dan dutifully fed the course correction into the auto-con.

"All systems green," John reported, sounding as tired as he and Doris looked. Their flight suits were rumpled and sweat-soaked.

Dan sniffed theatrically. "I'll keep the con awhile," he told John. "Why don't you two go clean up, before the air in here becomes toxic."

"That's the smell of honest labor," Doris replied. "You ought to try it sometime."

Doris beat John to the head, so John ended up in the galley. "Who wants coffee?" he asked over the com.

"Your captain," Dan replied, and Doris's affirmative came from the speaker.

Fifteen minutes later Doris and John, sponge-bathed and wearing fresh flight suits, were back in their seats. The three of them were drinking coffee and arguing about the upcoming Calgary Cup semi-finals. The *Condor* was flying over dark blue, iceberg-dotted ocean; the air was clear and smooth. Dan was as relaxed as he ever let himself be while he had the con.

But the sky held traps which were invisible: air pockets, clear air turbulence, wind shears, microbursts. The doppler radar's alarm and Dan's pilot instinct went off at the same time. Too late. He was desperately revving the motors and trying to bring the nose up, when a power-forge slammed down on the *Condor*.

Dan and his crewmates hit the cockpit ceiling hard. His world blurred. He fell across his seat, banging his head again on the throttles. Through a darkening haze he saw Doris sprawled on the deck and John slumped against the navigation console, unmoving except for the streams of blood. Then he blacked out.

The *Condor* dropped twenty-six hundred feet before it managed to escape the trap. It buckled and groaned under the strains, but only a few of the bag cells ruptured. It was still airworthy. The auto-con restored trim, pumped helium into more cells to maintain al-

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titude, and brought the blimp back to the programmed course.

Its crew unconscious or worse, the *Condor* flew on.

The four windriders which made up the town of Calgary were floating a few miles apart, high above the patchy clouds and the ocean.

A windrider was a sophisticated superpressure aerostat: a hot air balloon. Its clear plastic shell was a globe a mile in diameter. The bottom third of the globe was divided into public, residential, and engineering levels, with the ground level holding the farm and park on top. A greenhouse effect kept the air inside a windrider warmer and therefore lighter than the air outside, enabling it to float up to thirty-five thousand feet above sea level. It traveled by changing altitude and sailing the air streams to its destination. It was an almost self-sustaining habitat in which six hundred or so folks lived. When it was above ten thousand feet, its air was enriched with oxygen and carbon dioxide. The oxygen was produced by a fractional distillation plant, while the carbon dioxide came from the folks and the farm stock. Solar cell panels in the top of the shell supplied its power.

In Calgary Three, fourteen-year-old Wanda Grigg was fidgeting in her chair in the back row of Teacher Kinney's English class. Wanda was supposed to be listening to Michael, who was standing beside the teacher's big desk reciting his bookdisk report. Actually she was staring at Jeff, two desks up and one to her right. The unrequited love of her life was whispering something to Adrienne the Overendowed. Jan, Wanda's best friend, sat on the other side of Adrienne. Hopefully, she was tuned in on them.

Wanda couldn't wait until class was over to find out. Personal coms weren't allowed in school, for what she considered petty and unfair reasons, so she looked at her desk's computer terminal. Her last try at finding an unblocked route to Jan's terminal, through the trim system's telemetry, had gotten her a trip to the principal's office and two weeks of down time at home. But this was an emergency. Her hand sneaked toward the keyboard.

It jerked back guiltily when her desk's com beeped. The call couldn't be from Teacher Kinney; the old bat was listening to Michael. Wondering what Mom or Dad wanted, Wanda put on her study headset and thumbed the receive button.

But it wasn't either one. Teacher Ware appeared in the tiny screen. "Hello, Wanda. Am I interrupting anything important?"

He was, but she could hardly tell him what. "I guess not," she said softly.

"Good. I'm going to try to get your teacher to cut you loose for awhile. I need you here in the lab."

Getting out of class was one of the reasons Wanda had agreed to help Teacher Ware with his project in the first place. But his timing was lousy. "What's up?" she asked.

"The bridge reports a fireball is on its way here. The EM signature indicates it's your pet Puff. Can you confirm that?"

Wanda forgot all about Jeff in her excitement. Puff was coming to play with her! It had been *weeks* since Puff's last visit. Closing her eyes, she listened/reached out with her special sense

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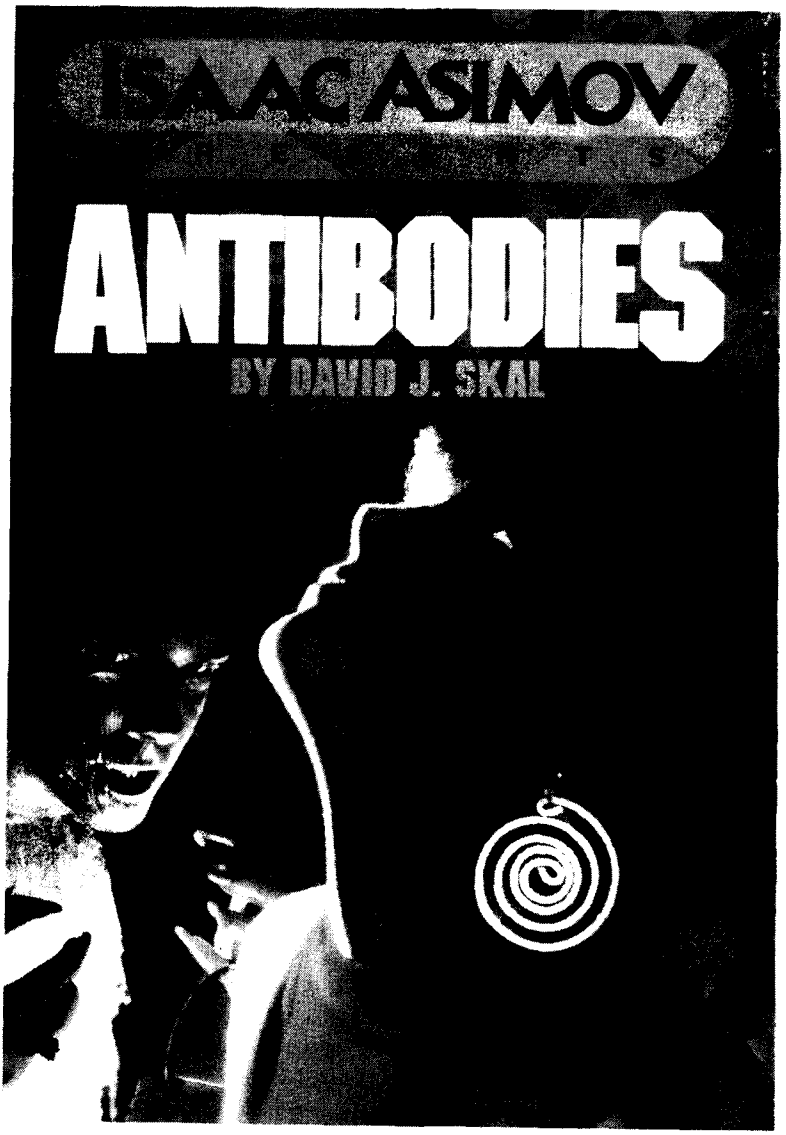

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as far as she could. It was something like talking and something like touching. It wasn't a really good way to communicate; all she and Puff could exchange were feelings and vague impressions.

She heard/felt Puff's voice/presence, faint but growing. "It's Puff, all right!"

"Good. Hang on, while I clear it with your teacher."

Teacher Kinney's attention was attracted to her desk's com. After a short whispered conversation she turned an irritated expression to Wanda and nodded.

Wanda walked self-consciously to the door, aware of all the curious eyes following her. The school corridor was empty with everybody in class. She headed for the electronics lab.

The pre-War surface civilization had known fireballs as ball lightning, flying saucers and religious signs. When the windriders had gone aloft, sensor probes had discovered them by the thousands roaming in the ionosphere, from which they sometimes came down to visit the windriders and the surface. They were self-contained fields of force, probably solar-powered. Ranging from Ping-Pong ball size to big ones like Puff, who was sixteen feet across, they could glow any color, or colors, or be invisible. They traveled alone and in groups. Scientists were still arguing over whether they were a form of life, or an atmospheric phenomenon like lightning or the northern lights.

Wanda thought the argument was stupid. Puff was as alive as she was, and smart, too. Over a year ago Teacher Ware had gotten her whole class to try to contact a fireball who was playing around Calgary Three, looking for one of the rare folks who had the special sense. That was how she had first met Puff. Puff was the best pet anybody ever had, and they loved each other.

The electronics lab wasn't scheduled for a class this period, so it was empty except for Teacher Ware. He was fussing with some equipment on a table near the window wall. Wanda glanced out the shell section at the bright noontime sky, but Puff wasn't in sight yet. She zigzagged through the desks and tables toward Teacher Ware.

He looked up and grinned. "Hello, Wanda. Thanks for coming."

"No problem, Teacher," she lied politely. She looked at the equipment on the table. She remembered the computer, EM monitor, recorder and cables running to the sensors mounted outside the window wall from other sessions. But she didn't recognize the component Teacher Ware was closing up. "What's that?" she asked.

"It used to be one of the hospital's EEG's. I've modified it to let me study the electrical activity in your brain. I hope to figure out how you and Puff communicate. Nishio's telepathy theory is hogwash—I don't believe in ESP. Fireballs must somehow be able to pick up the synaptic discharges in certain human brains."

Wanda stared nervously at the cluster of electrode-tipped wires. "Will it hurt?"

"Absolutely not, I promise." Teacher Ware gestured to a chair beside the table, facing the window wall. "Please sit down."

She settled into the chair. Teacher Ware carefully stuck the electrodes on her head, then fussed some more with

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the equipment. "Puff is almost here," he said.

"I know." Wanda could hear/feel Puff's voice/presence strongly now.

Suddenly a pale blue dot soared down out of the sky. It grew as it came closer to the window wall, turning into a glowing ball of light. It slowed and stopped about fifty yards from the window wall. "Hi, Puff!" Wanda yelled. She heard/felt Puff's happiness, and echoed it.

"What do you want me to do?" she asked Teacher Ware.

"Just keep communicating with Puff, so I can collect some readings from both of you."

"OK." Wanda looked back at Puff. White flashes were flaring out from Puff's middle, a sure sign that she was excited. Soon she would start frolicking or put on a light show. But Teacher Ware wanted them to communicate, so Wanda communicated. Puff was a great listener, even if she didn't understand much, and a lot had happened since her last visit. So, thinking instead of talking to keep Teacher Ware from overhearing, Wanda started telling Puff the latest news.

After Teacher Ware was done with her, Wanda headed home for lunch. Her family had a big rim apartment with window walls in the living and dining rooms, thanks to Dad being one of Calgary Three's chief engineers. He was in the den talking on the com. Mom was putting lunch on the dining room table. Wanda helped her, then they sat down and waited for Dad. The monitor propped next to Mom's plate let her keep track of the baby, who was asleep in the nursery.

Wanda was telling Mom about Puff's visit and trying to ignore the aroma of the fried chicken, when Dad came in. Wanda noticed that he looked worried. Mom must have, too, because she asked, "What is it, dear?"

"Bad news. Four's blimp *Condor* has dropped out of com—no warning, no explanation. It was just starting back from a water pickup. Three has the only blimp that isn't out scavenging or on intra-town shuttle duty, so the mayor is sending us to the rescue."

"I hope we can help," Mom said. "What are we going to do?"

"That's what Edie, Chris and I were just deciding. We're going to leave the rest of Calgary, descend into a wind at eighteen thousand feet that will bring us close to the pickup site in about thirty hours. Meanwhile the *Raven* is being inflated. As soon as it's ready to fly, it'll scout ahead along the *Condor*'s return course."

"One blimp isn't much to cover such a big search cubic."

"It'll have to do. Of course we're monitoring radio and radar, and notifying all nearby windriders and zeps. Can you think of anything we've missed?"

Mom had been a chief engineer, too, before retiring to making babies. After a moment of silence she answered, "Not a thing."

"I'm afraid I'll have to skip lunch," Dad said regretfully. "Too much to do before the *Raven* is ready to fly. I'll be going along, so don't hold dinner."

Mom nodded like she had been expecting him to say that. "I'll pack some of the food, so you can eat when you have time."

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"Thanks, hon."

Mom fixed the sack lunch, then Dad kissed her and Wanda and hurried off. Wanda and Mom ate without talking much. Wanda knew enough about blimps to realize that the *Condor* had probably crashed in the killzone. She hoped Dad could find it and save the crew members.

Wanda was on her way back to school for her afternoon classes, when the idea came to her. She had been daydreaming about how impressed Jeff would be if *she* rescued the *Condor*. Maybe it would get his mind off Adrienne's chest. But what could she do? Then she remembered a pre-War pubvid she had seen a few months ago, about a surface animal, called a dog, finding a crashed airplane. Of course a dog wouldn't be much help in finding a blimp, even if Calgary had a dog, which it didn't.

But she had Puff!

She was sure Puff could find the *Condor* wherever it was. Teacher Ware talked a lot about the unusual talents of fireballs, but she didn't need him to tell her how wonderful Puff was. The problem would be how to explain to Puff what she wanted. Her special sense wasn't like talking or typing. But she knew the things it could do as well as the things it couldn't, and there might just be a way.

Deciding that the chance of finding the *Condor* was more important than math class, Wanda turned around and took the escalator up to the ground level.

The bright sunshine made her squint. The ground level was like a plate almost a mile across, with the park in the middle surrounded by the farm fields and stock pens, all covered by a bowl of clear shell. The sky outside the shell was blue and beautiful. Wanda walked toward the rim, saying cheerful hellos to the picnickers and farmers she knew. Luckily nobody asked why she wasn't in school.

Finally she came to the rim. Calgary Two hung in the sky a few miles away like a glistening soap bubble. Her special sense could reach Puff from anywhere in the windrider, but she liked to actually see Puff when they were chatting. She could hear/feel Puff not too far off, probably eating sunshine. She called/reached out as hard as she could.

A few minutes later Puff soared down out of the sky and hovered about fifty yards beyond the shell. Fireballs played around windriders a lot, so the farmers didn't pay much attention.

Wanda was ready to try her notion. Closing her eyes, she imagined a condor-insigniaed blimp flying through the sky as clearly as she could, and yearned for it like she yearned for Jeff. She heard/felt Puff's interest and confusion. She tried harder, sweat popping out on her forehead. But Puff's only reaction was more confusion.

Finally Wanda gave up. Opening her eyes, she saw that Puff's usual pale blue fire had turned pulsing purple. She could hear/feel as well as see that Puff was upset. A few minutes of soothing calmed Puff down, then Wanda tried to figure out another way to get her message across.

She couldn't.

In her frustration she decided to do the unthinkable: ask an adult for help. Teacher Ware knew a lot about fireballs. Maybe he could come up with a way.

"I'm going down to the 'tronics lab,"

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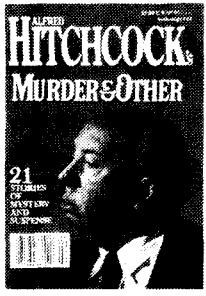

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Wanda told Puff. "See you there." She turned and started back to the park escalator.

She figured Teacher Ware would still be fussing with his equipment, and she was right. He looked up as she walked into the electronics lab. "Hello, Wanda. Forget something?"

"No, Teacher. I need some help. Did you hear about the missing blimp?"

Frowning, he got up out of his chair. "What missing blimp?"

So she told him about the *Condor* and her notion of getting Puff to find it. Teacher Ware's frown turned into an excited look. "That's a brilliant idea, Wanda! I've been planning to experiment with communication by visual images—it just might work."

"But it didn't," Wanda said plaintively.

Teacher Ware leaned over the computer and started typing. "Your theory is sound. You just made one unreasonable assumption—that fireballs see the same way we do."

"Huh?"

"Visible light is only a small part of the EM spectrum. If fireballs have a visual sense as we know it, which they may not, it could be infra-red, ultra-violet, X-rays, radar or whatever. You have to visualize the *Condor* the way Puff would see it."

Wanda felt her great scheme to become a heroine crumbling. "How can I do that?"

"Sit here." He slid his chair in front of the computer's screen. The screen showed a close-up picture of the *Condor* in flight. Mystified, she sat down.

"Is Puff nearby?" Teacher Ware asked her.

Grinning, she said, "Look out the window wall."

He did. Puff was hovering there patiently, but Wanda could hear/feel her curiosity.

"Good." Teacher Ware touched buttons on his equipment, and stuck the electrodes on Wanda's head. "I hope you don't mind being monitored," he said as he worked. "This experiment could provide invaluable scientific data."

Wanda shrugged.

"Watch the screen, and try to communicate what you want Puff to do," Teacher Ware told her. "Just like you did topside."

"OK." Wanda stared at the *Condor* and yearned for it. Puff just turned pulsing purple again.

Teacher Ware typed on the computer's keyboard, and the picture changed. Now black and white, the blimp was dim except for the car and the motor gondolas. "A simulated infrared image," Teacher Ware explained.

Wanda could hear/feel Puff's upset. There wasn't any sign that she understood. "It's not working," she told Teacher Ware disappointedly.

"Don't give up yet. There are several more possibilities to try. Radar next." The picture changed into a white blimp-shape against a black background.

There were sixteen pictures, and Teacher Ware ran through them three times. Wanda's eyes and head hurt from staring and thinking so hard for so long. At the end Puff was still hovering, pulsing more purple than ever. "Nothing," Wanda told Teacher Ware. "I'm sorry I wasted your time. It was a stupid idea."

"Negative results don't make an ex-

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periment a waste of time. Of course it's unfortunate that Puff won't be able to help rescue the—"

Suddenly Puff flared so brilliantly white that Wanda had to shade her eyes. She heard/felt an overwhelming wave of happiness. Puff swooped through a beautiful series of elipses around a common center, then soared away at top speed. In seconds she was gone.

"What in the sky was that!" Teacher Ware gasped.

"I don't know," Wanda admitted.

They both stared at the empty sky for awhile. Then Teacher Ware started turning off his equipment. "I guess that's that," he said.

Wanda couldn't hear/feel Puff anymore. She felt lousy.

"By the way, shouldn't you be in class?" Teacher Ware asked her.

Reality burst her dream balloon. Checking her watch, she saw that she had missed one class and most of another. With no rescued *Condor* to justify her absence, she was in ultra-trouble. "Yipes! Yes! I've got to go!"

Teacher Ware grinned. "If you need an excuse, have your teachers call me. I'll explain why you were here."

"Thanks a lot! Wide sky!"

Wanda hurried along the conspicuously empty corridor toward her history class. She wasn't looking forward to explaining her absence to her teachers, or to Mom and Dad. Jan was the only one she could tell why she had really wanted to find the *Condor*. She would absolutely die from embarrassment if Jeff ever found out—

Suddenly she heard/felt Puff's voice/presence, growing fast. Puff was coming back.

Wanda's dead hope came back to life. Closing her eyes, she tried visualizing the *Condor* and yearning for it again.

She heard/felt Puff's answering burst of success and pride.

She started to run back to the electronics lab, then stopped. No time to tell Teacher Ware. The *Raven* was probably almost ready for launch. She had to find Dad. Spinning, she ran to the escalator.

On the way down she kept in rapport with Puff, so Puff wouldn't wander off. She visualized the *Raven* following Puff to the *Condor* over and over, but she couldn't tell if Puff understood.

The blimp bay was the next-to-bottom level, just above the bridge. It was big enough to hold a pair of inflated blimps plus all their gear, and it was bright with sunshine from the ring of window wall. As Wanda got off the escalator, she saw that most of the activity was to her right, where the bay crew was pre-flighting the *Raven*. She spotted Dad near the blimp's car, talking to a woman in a flight suit. She ran over.

"Dad!" she gasped when she reached them. "I have to talk to you! It's important!"

Dad turned, looking surprised. "What are you doing here, Wanda?"

"We're just about ready to go," the woman said to Dad, and frowned at Wanda. "We don't have any time to waste."

"I know," Dad answered her. "Why don't you go aboard and start running the checklist—I'll join you in a minute."

"You're the boss," she muttered, and headed for the car's open hatch.

It was Dad's turn to frown at Wanda.

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"You can see how busy I am. So out with it."

Wanda spilled out her story as quickly as she could. When she was finished, Dad didn't say anything for a few seconds. Then he grabbed her by the shoulders and stared at her so hard that she flinched. "This is no time for imagination or wishful thinking. Are you *absolutely* certain?"

"Uh . . . yes. At least I'm sure Puff found the *Condor*. I think I can get her to lead you to it."

"I hope you're right. Come on."

"You're going to take me along with you?" Wanda asked hopefully.

"I have to—you're the only one who can communicate with Puff. I'll call Mom to tell her after we launch. No time now."

She followed Dad into the *Raven*'s cargo hold. He sealed the hatch, then they went forward along the cramped corridor to the cockpit.

The woman was strapped in the pilot's seat, flanked by two younger men. As Dad pulled down the two observation seats built into the rear bulkhead, the woman turned her head and noticed Wanda. "What the hell, Jack?" she snapped. "This isn't a school field trip."

"This is my daughter, Wanda. She's in rapport with a fireball who is going to guide us to the *Condor*."

The other two crew members turned to stare at Wanda. "You don't really believe that life-form crap, do you?" the woman asked Dad.

"Puff is too alive!" Wanda erupted.

"Puff?" one of the men asked.

"I named her after Puff, the magic dragon. From an old song."

"You're the boss," the woman said sourly to Dad. "But the *Condor's* crew could die while we're wasting time with this fantasy."

Dad locked eyes with her, wearing his chief engineer face. "I assure you I've weighed all the factors, and I'm well aware of the consequences of my decision. I trust my daughter. What she tells me convinces me it's worth a try."

The woman didn't look convinced, but she forced a smile as she turned to Wanda. "Welcome aboard. I'm Rayna Charles, the captain of the *Raven*. These gentlemen are Harold Smithson and Sam Cades." The men nodded.

"Pleased to meet all of you," Wanda replied more politely than she felt.

Rayna was distracted by a message coming in over her headset. Then she said, "Jack, Wanda, better strap in. The bridge has cleared us to launch."

Wanda fastened her seatbelt, and looked around in rapt fascination. She had never seen a blimp launch from its cockpit.

Rayna and her crewmates were busy working controls, reading instruments and making status reports. Dad was sitting calmly, not distracting them by saying anything. Soft equipment sounds filled the cockpit as the *Raven* came to life. Beyond the windscreen Wanda could see that the bay crew had put on their outside suits, and that the escalator and stair wells were sealed. The bay was probably already depressurized to match the air outside Calgary Three.

Cables strung from ceiling tracks lifted the *Raven* out of its cradle, and moved it sideways to the south docking hatch. The two rectangular floor sections swung down ponderously, reveal-

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ing clouds and dark green surface below. The blimp was lowered through the barely-big-enough hole. Wanda stared up at the white plastic belly of Calgary Three, and the round window that was the floor of the bridge.

"Hang onto your guts," Rayna warned everybody. "I'm about to yank the rip-cord."

She got final clearance from the bridge. Then she touched a button, and the *Raven* dropped like a rock.

Windriders took a long time to descend, and Calgary Three was still way above a blimp's flight ceiling. So the *Raven* was being drop-launched. The uncontrolled freefall only lasted a few scary seconds. Then the blimp's nose dipped, its motors growled fiercely, and the drop turned into a steep dive. The dive went on for what seemed to Wanda to be a really long time. Her stomach complained. Finally she was squeezed down into her seat, and the blimp groaned, as Rayna started to pull out of the dive. The blimp levelled off just above the clouds at sixteen thousuand feet, and came to a northeast course.

Dad turned to Wanda. "Where's Puff?"

Puff's voice/presence had been in the back of Wanda's mind all along. Now Wanda concentrated on it. "She's pretty close. Do you want me to call her—oops, no need. Look." Wanda pointed out the windscreen.

Puff had appeared like magic, and was spiralling friskily about a hundred yards in front of the *Raven*. "Damned menace to navigation," Rayna muttered.

"Now try to get Puff to lead us to the *Condor*," Dad said to Wanda.

"OK." Wanda yearned again. This time she heard/felt Puff's understanding and enthusiasm right away. White flashes of excitement shot out from Puff's middle. Then Puff soared away from the *Raven*, a few degrees to starboard of the blimp's flight line.

"Change course to follow the fireball," Dad told Rayna.

She swiveled to face him, looking angry. "That's way off the *Condor*'s reported course! Your anthropromorphic ball lightning is leading us on a wild goose chase! I strongly recommend we stick to the planned search grid!"

Dad frowned for a moment, and Wanda figured he was going to give in. Then he squeezed her hand. To Rayna he said firmly, "I appreciate your advice. But the *Condor* could have gone off course. I still think Puff is our best hope to find it ASAP."

"This is crazy," Rayna muttered. But she brought the *Raven* around to follow Puff.

Dad included the message to Mom in Harold's com report, as the *Raven* cleared Calgary Three's airspace. Puff kept racing ahead of the blimp, then coming back and playing around it. Wanda could hear/feel Puff's impatience at the blimp's slowness. Wanda stayed in close rapport with Puff, cheering her on.

The chase soon became pretty boring. Wanda felt left out of the adult shop talk, so she spent most of the time watching and listening to Puff. Sam fixed everybody a ration pak snack. The afternoon dragged by.

The Sun was almost down, when Puff and the *Raven* reached the cubic where

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the *Condor* might be if it was still aloft. The surface was now gray ocean, so there wasn't any point looking for a crash site.

"Nothing on radar," Harold reported. "No com response."

Rayna glared at Dad. For the first time Wanda worried that she might have misunderstood Puff. Not only would she get down time for the rest of her life, but Dad would be in big trouble. And if the *Condor*'s crew died because of it. . . . Sweat popped out on her forehead, and her stomach knotted.

She heard/felt Puff's soothing reassurance.

"I've got something!" Harold said. "Blimp signature, thirty-five miles dead ahead. No transponder."

"Raise it," Rayna snapped.

Harold put on his headset, touched com buttons, then spoke into the mike. "Calgary blimp *Raven* to unidentified blimp. Do you copy?" He repeated the call over and over. Finally he stopped and turned to Rayna, shaking his head. "No reply."

Rayna punched up the radar data on her board. "Altitude eight thousand five, course one one oh, speed forty-two MPH. If that's the *Condor*, why in the sky is it heading east?"

"Let's take a closer look," Dad told her.

"On it." Rayna's hands and feet worked controls. "I'm going to match its course and bring us alongside."

The *Raven* descended and swung away from the setting Sun. Wanda could feel the tension in the cockpit. Nobody was saying anything; everybody was staring at the darkening sky.

Finally a long black shape appeared ahead and to port. It grew, turning into a blimp like the *Raven*. It looked OK to Wanda.

Harold had a pair of electronic binoculars trained on the blimp's nose. "Bingo! It's the *Condor*, all right—I can see the insignia."

Rayna turned to face Dad and Wanda, looking surprised but very relieved. "Folks, I guess I owe you and your fireball a big apology. If we had gone with the search pattern, we never would have found the blimp."

"I told you Puff could do it!" Wanda erupted at Dad. He gave her a quick smile.

"Why aren't they answering us?" Sam wondered aloud.

"Could be com trouble," Dad suggested. "Let's move in closer, and try Morse signalling with our running lights."

"On it," Rayna replied. She started narrowing the gap between the two blimps.

Puff flew back to the *Raven*, showing off a few fancy maneuvers. Wanda congratulated and thanked her, and heard/felt her pride. But Puff seemed tired. Her blue fire was dim. She sent Wanda a burst of love and warm golden light, then soared west to find the Sun.

Wanda was the only one who saw Puff leave. She missed Puff already.

The adults were busy trying to make contact with the *Condor*. It was now a shadowy shape about a hundred yards to port, flying without running lights in the dusk. Finally Dad said, "Enough. They aren't answering."

Harold dropped the binoculars in his lap. "I don't see anybody in the cockpit.

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And without a comlink we can't even slave their flight controls to ours."

"Maybe it's a ghost blimp," Sam suggested grimly. Wanda remembered stories about blimps whose crews had been killed by diseases left over from the War, and shuddered.

"BW bugs don't work that fast," Dad replied. "But something is definitely wrong."

"Now what?" Rayna asked him.

He unstrapped and stood up. "I'm going aboard the *Condor*."

Wanda's jaw dropped, and the adults looked almost as shocked. "How do you figure on doing that?" Rayna demanded. "Get your friendly fireball to carry you? Or float over on sheer force of personality?"

"A midair transfer. SOP."

"The hell you say! The procedure assumes you have a cooperative pilot on the other end. If I tried to put you down on that runaway, you'd end up smashed, shredded or splashed."

Wanda snorted. She didn't know what a midair transfer was, but the notion that Dad couldn't do something he said he could do was ridiculous.

Dad put a hand on Rayna's shoulder. "If anyone else was at the *Raven*'s controls, I wouldn't even consider it. I have complete confidence in you."

"Well, that makes one of us." Rayna shrugged. "You're the boss. Sam, Harold, rig for zero-tolerance maneuvering. Wanda, pretend that you don't exist."

"Yes, ma'am," Wanda replied meekly.

Dad kissed Wanda on the cheek. Then he ducked through the corridor hatchway.

* * *

Jack Grigg didn't feel heroic. Heroism was usually the result of insufficient planning or poor execution, and good engineers tried to avoid those sorts of things. Getting aboard the *Condor* was a problem in applied engineering. He intended to accomplish it in the safest, most efficient way.

Of course, even the safest solution had a tiny, unavoidable element of risk.

The *Raven*'s cargo hold was empty except for the rescue gear stowed in the stern. Jack put on his outside suit and ran through the safety checks, then he clipped some tools he might need to his belt. Switching his helmet com to the *Raven*'s channel, he said, "Harold, Jack here. Put Rayna on."

"You've got her." Rayna's sharp voice came over the helmet's speaker. "I'm going to leave this line open, but try to keep the conversation to a minimum. I've got some fancy flying to do."

"Can do," Jack acknowledged. He braced himself as the *Raven* banked and the motors revved. Both blimps were flying at reduced night cruising speed, running on their batteries. That would make Rayna's job somewhat easier.

Going over to the bulkhead-mounted control panel, Jack activated the winch and ran it on its overhead track to a position above the belly hatch. Then he fetched a control unit and a pair of thousand-pound line reels from their racks. He stepped carefully onto the hatch, loaded the reels on the winch, and clipped the free ends of the lines to his suit's shoulder hooks. "I'm ready," he reported over the com.

"Same here," Rayna snapped. "Last chance to come to your senses."

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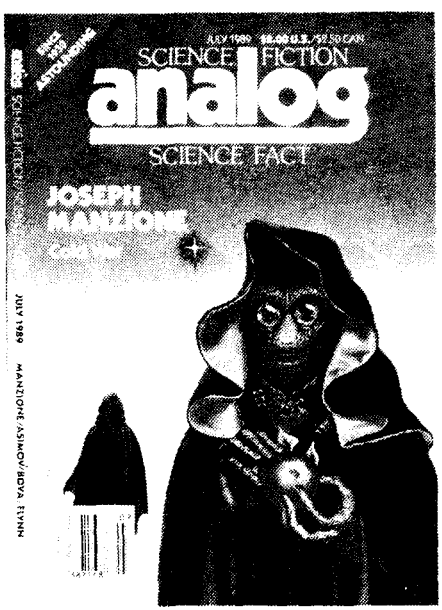

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"There are some folks aboard the *Condor* who might need our help."

"OK, the hold is sealed and the belly hatch is released to your control. Good luck, Jack."

"Thanks, Rayna."

Jack touched a button on the control unit, and the winch took in the lines until he was lifted a few feet above the hatch. Another button started the two halves of the hatch swinging up and out. Wind whipped into the hold, rocking him. The suit's temp control kept him from feeling its bitter cold, but even with the sound pickup off, he could hear it howl.

He looked down.

The twilight was gray, and the surface was cloaked in shadow. Fifty feet down the back of the *Condor* was bouncing around despite Rayna's phenomenal job of outguessing the air currents. One of the *Raven*'s spotlights managed to keep the lustrously black photovoltaic skin in its beam most of the time. For a moment Jack stared, thinking about his family and the element of risk. Then he said, "I'm starting down."

"About time. This zero-zeroing isn't easy."

Jack touched another button, and the winch slowly unwound the lines. The wind blew him sternward as he was lowered through the open hatch. He fended off the rim with his feet and hands. Then he was dangling in the sky.

He wasn't quite the aerophile that Wanda was, but he had done enough hang-gliding and outside suit work to feel reasonably comfortable. Facing astern, he admired the impressive view of the *Raven*'s running-light-illuminated belly set against the starry blackness. The last red glow of sunset lined the western horizon. The wind was a strong, steady hand pushing him from behind.

He forced his mind back to business. He stopped his descent ten feet below the hatch and peered down at the gleaming curve of the *Condor*'s back, hunting for the topside emergency hatch. The bucking and the irregular lighting made the task difficult, and he was beginning to feel a bit airsick. Finally he spotted the yellow circle. "Back forty feet, port fifteen," he rapped into the com.

"And how many inches?" Rayna replied sarcastically. But Jack found himself moving in the right general direction. He started down again.

He stopped ten feet above the mean level of the *Condor*'s back, and waited. The bucking made the skin look like a patch of surface in the throes of a legendary earthquake. When the yellow circle lurched to a position roughly under his suit's boots, he started down again.

Suddenly the *Condor* jumped up at him.

It knocked his legs out from under him, and he hit the skin (or vice versa) flat on his back. The blow drove the wind out of his lungs despite the skin's pneumatic give. He stared up dizzily to see if he was about to be squashed between two blimps. But the *Condor*'s abrupt climb stopped a handful of feet shy of the *Raven*'s looming belly.

Taking advantage of the momentary stability, Jack rolled over and crab-crawled as quickly as he could toward the emergency hatch twenty feet away. The skin's slope and slickness made the going very treacherous.

He was three feet from the yellow

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circle, when the *Condor* lurched to starboard and dropped. The smart move would have been to let the lines yank him aloft and try again. But instinct kicked in before reason could.

He lunged for the emergency hatch, and slid out of control across it. His gloved right hand grabbed the thin plastic strip that was one of the handholds. His left hand dropped the control unit and slapped the suit's shoulder hook releases.

The control unit was blown sternward on its way to the Long Drop, while the freed lines snapped up like whips. Jack was busy trying to avoid following the control unit. Clinging desperately to the handhold, fighting the slipstream and the *Condor*'s gyrations, made him feel like a stampede bronc-buster. His right arm screamed in agony. But he managed to hang on, while his left hand pulled a short line from his belt and clipped the free end to a hook on the hatch's perimeter.

Safe! For the moment. Jack spread-eagled flat against the skin to minimize the slipstream's pressure, let the line take most of the strain off of his arm, and remembered to breathe. "I'm down and secure!" he gasped. "Get clear!"

"On it," Rayna replied crisply. Jack felt rather than saw the *Raven* climb away.

The spotlight-less darkness was almost complete, so Jack switched on his helmet lamp. After some fumbling with the catch he managed to unzip the hatch. The access shaft, a plastic tube held rigid by the inflation of the surrounding cells, had ladder rungs running down one side. He carefully pulled himself into the shaft, unclipped the belt line, and zipped the hatch shut over him.

"I'm in the shaft and starting down," he reported.

"We're clear," Rayna replied. "The *Condor* is still holding steady, and the air up ahead looks clear. But I wouldn't waste any time if I were you."

"My thought exactly." Jack descended rung by rung, an awkward process due to the outside suit. The shaft was only two hundred and ten feet deep, but it seemed much deeper. He was sweating profusely, despite the suit's temp control, when he reached the top of the car.

Opening the hatch, he dropped down to the deck of the cargo hold. It was dimly red-lit by emergency lights, and crowded with drilling gear and a big water tank. There were no crew members in sight. He paused a moment to catch his breath, then shed his suit and went forward.

As he moved along the red-lit corridor he quickly checked each compartment, but they were also empty. Cold fear began to spread through his nervous system. His heels clicked hollowly on the deck, and the muted motor growling spoke of machines carrying on without human supervision. The *Condor* felt abandoned. He was eerily reminded of Sam's ghost blimp remark.

But Jack wasn't afraid of ghosts. He was afraid of grim reality.

A fetid smell was coming from behind the closed cockpit door. Jack's hand paused on the latch, trembling. He had to make himself open the door.

It was as he had feared, only worse. Two members of the *Condor*'s crew lay sprawled on the deck; the third was

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slumped over the navigation board. They all had ugly looking scalp wounds covered with clotted blood, and there were large brown stains on the deck and board. He didn't see any signs of life.

His heart told him to go over to the crew members, to help them if it wasn't too late. But his head reminded him that first things had to come first. Stepping over one of the still bodies, he dropped into the pilot's seat.

He was breathing raggedly through his mouth to avoid the slaughterhouse reek, and his hands weren't as steady as usual. But he went to work. He called up the diagnostic program for the flight systems. The readout told him that the *Condor* was low on power and lift, but in no immediate danger of splashing. He did what he could from the board to improve the situation, and noted the repair jobs he would have to do ASAP.

Only then did he turn his attention to the crew members. He checked for pulses, and was greatly relieved (if somewhat surprised) to find three weak ones. He carried the co-pilot, who had leaked the most blood, back to the auto-med. He stripped the co-pilot, placed him in the coffin-like treatment module, and hit the button for emergency care. By the time he returned with the captain, the module's lid had popped up. He put the captain in, then carried the co-pilot (plus the IV/monitor the auto-med had hooked up to him) to a cabin. Soon all three crew members were tucked into bunks. The auto-med reported that they were in critical condition from concussions, loss of blood and shock, and told him what to do for them until they reached Calgary Three's hospital. The prognosis for complete recoveries was favorable.

He returned to the cockpit. The night beyond the windscreen was black except for the stars and the *Raven*'s running lights a few hundred yards to starboard. He switched the com to the *Raven*'s channel. "Rayna, Jack here. Do you copy?"

"I copy. About time you checked in."

"I've been busy." Jack let his weary body sag into the pilot's seat. "The *Condor* is marginally airworthy. All the crew members are alive but in bad shape. I'm going to be patching cells and playing nurse, so you'll have to fly this bay. Stand by to slave the controls."

"All green at our end," Rayna replied.

Jack coded instructions into the com and the auto-con. Moments later a readout confirmed that the *Raven* had the con. "You're on line," he reported to Rayna.

"Good. Hang on—we're going home."

The cockpit listed to starboard as the *Condor* followed the *Raven* around to the new heading.

"—so we got back in time for breakfast," Wanda told Puff. "The rescue was a pretty big deal for a few days. The crew members are OK—I visited them in the hospital while they were recovering. Mom and Dad said they were proud of me."

Wanda was lying on her back on one of the catwalks that ran among the solar panels. Down on the ground level tractors were plowing farm fields and folks

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were swimming in the lake, but she had the top of Calgary Three's shell all to herself. She was looking up through the clear canopy at Puff frolicking in the afternoon sky.

"My scheme didn't turn out so well, though. The newsnet stories made Dad look like a hero—which he was, of course—but we either got left out or made fun of. Hardly anybody believes you found the *Condor*. The gang teased me ragged, and Jeff is still hypnotized by Adrienne's chest. Then there's the week of down time I got for skipping classes without permission."

Twelve days had passed since the rescue, and Wanda was more than ready to put the whole thing behind her. But this morning she had received a mysterious message from the *Condor*'s Captain Muscatine suggesting that she come here after school and bring binoculars. Since Puff had shown up again and it was a good place for a private chat, she had ridden up on an access belt.

"How can anybody think you're just some kind of ball lightning!" Wanda fumed. "It makes me so mad!"

Puff came down and hovered close to the shell, giving off a warm golden glow like a second sun. Wanda heard/felt her soothing comfort.

Wanda couldn't stay angry when Puff did that. She giggled. "Puff, you're the best pet anybody ever had, and I love you. I just wish—"

Something distracted Puff. Her usual pale blue fire returned and she soared toward Calgary Two which looked like a soap bubble in the distance. Wanda could hear/feel her excitement. Wondering what was up, Wanda peered in that direction.

It was just the shuttle blimp coming to Calgary Three. Wanda sighed. In some ways Puff was a big baby; she loved to chase airships. Their chat would have to wait a bit. Meanwhile Wanda would enjoy the show.

The blimp should have been heading for the docking hatches at the bottom of the shell. Instead it was on a course that would bring it low over the top, a major violation of airspace regs. It was going to pass almost above her. Wondering if it was in trouble, she trained the binoculars she had borrowed from Dad on it.

She didn't see anything wrong. Then she wondered if it was the *Condor*, and if this was why Captain Muscatine had asked her to come here. A flyby was supposed to be a really big honor among bagmen. But why her? She had told them her story, of course, but she had figured they would believe the newsnets instead. After all, she was just a "child with an overdeveloped imagination."

The blimp was almost over Wanda now. She saw folks waving to her from the cargo hold's ports and the cockpit's windscreen. Embarrassed as well as mystified, she waved back. Then she swung the binoculars to the blimp's nose to see if it was the *Condor*.

It was and it wasn't. She recognized the registration number, but the *Condor* name and insignia were gone. Instead, the gleaming white plastic wore a new decal: a pale blue ball of light streaking across the sky. Under it fiery letters read *Puff*.

Wanda let out a yelp of pure joy. Jumping to her feet, she gasped, "Puff, they renamed their blimp after you! You're famous!"

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Puff spiralled around the blimp, radiating bright white flashes and echoing Wanda's excitement. The blimp revved its motors in salute. Wanda applauded enthusiastically, and wetness blurred her eyes.

Wanda didn't know if Puff understood about names and insignias, but it didn't really matter. What mattered was that Captain Muscatine and his crewmates believed in Puff. Someday everybody else would, too. ■

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Ian Stewart

DICING WITH DEATH IN THE SOLAR SYSTEM

Newton's laws do describe the Solar System quite nicely—but under certain conditions they can produce results that look very "dicey" indeed!

The eternal battle between order and disorder, harmony and chaos, is a deeply felt human perception of the Universe, common to many creation myths and many cultures. In the cosmology of ancient Greece, chaos was both the primeval emptiness of the Universe, and the underworld where dwelt the dead. In Old Testament theology "the Earth was without form, and void, and darkness was upon the face of the deep." In an early Babylonian epic, *Enuma Elish*, the Universe arises from the chaos that ensues when an unruly family of gods of the deep is destroyed by its own father. Chaos is the original formless mass from which the creator molded the ordered Universe. Order is equated with good and disorder with evil. Order and chaos are seen as two opposites, poles upon which we pivot our interpretations of the world.

Man is not so much a rational animal as a *rationalizing* animal. Fearful of the unpredictability of chaos, we strive to understand the regularities in nature, to seek the laws behind the unruly complexities of the Universe, to bring order out of chaos. Even the earliest civilizations have sophisticated calendars to

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predict the seasons, and astronomical rules to predict eclipses. They see figures in, and weave legends around, the stars in the sky. They invent pantheons of deities to explain the vagaries of an otherwise random and senseless world.

The revolution of scientific thought that culminated in Isaac Newton led to a vision of the Universe as some gigantic mechanism, functioning "like clockwork." Pierre Simon de Laplace, one of the great 18th Century mathematicians, had a vision of a vast intellect, capable of predicting the behavior of the entire Universe from a single formula —an up-market version of Deep Thought, the ultimate supercomputer, in Douglas Adams's *Hitchhiker's Guide to the Galaxy*. Laplacian determinism made its mark: most of today's technology is based on this type of understanding of how to impose order upon an irregular world.

But now, mathematicians and physicists have discovered something rather curious. Order breeds its own peculiar kind of chaos. Deterministic laws—that is, equations that do not contain any random terms, which in principle describe the evolution of some system uniquely for all time—can in practice behave randomly. This is a remarkable discovery, and it is changing the face of science. It is known as *deterministic chaos*, or just plain *chaos*.

In thermodynamics, the tendency towards disorder is known as *entropy*. Terrestrial life is a triumph of order over entropy, of biological organization over the heat-death of the Universe. But disorder may have the last word long before the Universe sinks into the red entropic haze.

For centuries astronomers have studied the regularities of the Solar System—the orbits of the planets, the phases of the Moon, the paths of comets, the sunspot cycle. Now, equipped with the new mathematics of chaos, they can also study its irregularities. Some of these are important even for the most planetbound of our groundhog race: the workings of chaos could at any time drop a large asteroid onto the Earth, and wreak the kind of havoc described in *Lucifer's Hammer* (Niven and Pournelle) or *Shiva Descending* (Benford). Moreover, this cosmic destroyer need not be some unsuspected visitor from the depths of interstellar space. It could be any one of thousands of large rocks currently following regular and harmless orbits around the Sun at just the right distance between Mars and Jupiter. At any moment the precise, regular clockwork of the Solar System could throw a very unexpected spanner into the machinery of our Earthly existence.

Paradoxically, it requires a very precise conjunction of circumstances for such a disaster to happen—as we shall see towards the end of this article.

Voyage to the Hyperion

Chaos can also manifest itself in less harmful forms. We time-shift to September 5, 1977. A gigantic Titan III-E/Centaur rocket waits in readiness on the pad at Launch Complex 41, Air Force Eastern Test Range, Kennedy Space Center, Cape Canaveral, Florida. In its topmost stage, dwarfed by the

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giant but the reason for its existence, is a tiny triumph of engineering, the *Voyager 1* spacecraft (Fig. 1).

The countdown reaches its final seconds. Twin solid-fuel boosters, filled with aluminium powder and ammonium perchlorate, ignite with a roar that can be heard fifteen kilometers away. The rocket, tall as a fifteen-story building and weighing 700 tons, drags itself skyward from the bottom of the Earth's gravity well. At first its motion is painfully slow, and it burns a substantial proportion of its fuel in the first hundred meters. Yet within ten hours *Voyager 1* is further away than the Moon, en route for distant planets—Mars, Jupiter, Saturn.

Sixteen days earlier a sister craft, *Voyager 2*, has already made its departure: the launch of *Voyager 1* has been delayed by technical faults. In compensation, *Voyager 1* follows a faster trajectory, so that by the time it arrives near Jupiter it is four months ahead of its sister craft. Its mission will terminate after its close encounter with Saturn; but *Voyager 2* will continue to Uranus and Neptune.

The journey of the *Voyagers* is a miracle of engineering. It is also a miracle of mathematics. Mathematics governs the design of the probe and of its launch-vehicle. Mathematics computes the loads and stresses on its metal frame, the combustion patterns of its fuel, the dynamics of the air that streams past the vehicle's skin during its brief traverse

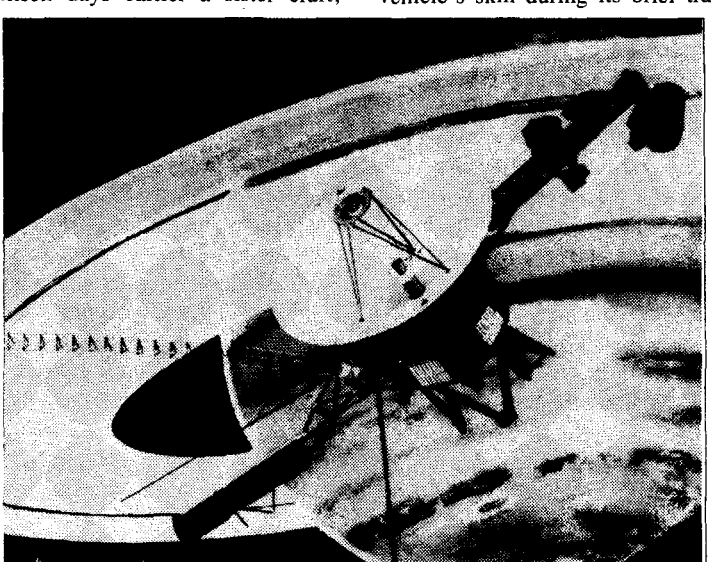

FIGURE 1:
Voyager approaches Saturn [NASA].

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of the Earth's atmosphere. Mathematics governs the electronic impulses that course through the computers as they monitor evey tiny step in the spacecraft's progress. Mathematics even decide the coding of the radio messages by which the Earthbound controllers communicate their instructions to the probe, which in time will transmit back to Earth breathtaking images of our Solar System.

But, above all, mathematics governs the stately celestial dance of the planets, their moons, and the paths of the *Voyagers* as they make their heavenly rendezvous. A single, simple law—Newton's law of gravitation. No need for Einstein's improvements—at the comparatively slow speeds that prevail in the Solar System, Newton suffices.

Were the Solar System inhabited by Sun and Earth alone, Newton's law would predict that they move in ellipses about their mutual center of gravity—a point buried deep within the Sun, because the star is so much more massive than the planet. Effectively the Earth should move in an ellipse with the Sun stationary at one focus. But the Earth is not alone in the Solar System—why else dispatch the *Voyager* craft? Each planet travels along its own ellipse—or would, were it not for the others. These perturb it away from its ideal orbit, speeding it up or slowing it down. The Cosmic Dance is intricate and elaborate: sarabande to a score by Newton, *largo con gravità*.

The law prescribes each step of the dance, completely, exactly. The calculations are not easy, but they can be performed with persistence and a fast computer, to an accuracy enough for *Voyager*'s purpose. Using Newton's mathematical laws, astronomers have predicted general features of the motion of the Solar System over 200 million years into the future. A few years is child's play in comparison.

Past Jupiter—a banded, swirling enigma —on to Saturn, a planet dominated by its rings. But Saturn has other features of interest, notably its moons. From Earthbound observations, the planet was known to have at least ten satellites: *Voyager* raised the total to fifteen.

One moon, Hyperion, is unusual. It is irregular in shape, a celestial potato. Its orbit is precise and regular; but its attitude in orbit is not. Hyperion is tumbling. Not just end over end, but in a complex and irregular pattern. Nothing in this pattern defies Newton's laws: the tumbling of Hyperion obeys the laws of gravitation and dynamics.

Time for a hypothetical exercise. Suppose that *Voyager 1* had been able to measure the tumbling of Hyperion to an accuracy of ten decimal places. It didn't, but let's be generous. Suppose, on this basis, that Earthbound scientists were to make the best possible prediction of Hyperion's future motion, predetermined according to Newton's law. Then only a few months later, when *Voyager 2* passed by Hyperion, they could compare their predictions with actuality. And they would expect to find . . .

. . . that the prediction was totally wrong.

A failure of prediction?

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Not exactly.

A failure of Newton's law?

Indeterminacy? Random outside effects, such as gas-clouds, magnetic fields, the solar wind?

No.

Something much more remarkable. An inherent feature of mathematical equations in dynamics. The ability of even simple equations to generate motion so complex, so sensitive to measurement, that it appears random. Hyperion's motion is chaotic.

Calculator Chaos

We aren't in a position to explain why Hyperion tumbles chaotically, but I can show you a more accessible example of chaos which you can experiment with for yourself. All you need is a pocket calculator or a microcomputer.

Newton's law prescribes the motion of Hyperion by using a *differential equation*. Suppose that, at a given instant, you know the position and velocity of Hyperion. Then there is a fixed rule, which you apply to these numbers, to get the position and velocity at the next instant. Then you just apply the same rule again, and keep going until you reach whatever time you want.

The equations for Hyperion involve many variables—position, velocity, angular rotation. You *could* put them on your calculator, but life is short. Instead, we'll choose a much simpler equation. It has nothing whatsoever to do with the motion of Hyperion; but it does illustrate the phenomenon of chaos.

My calculator has an $\mathbf{x}^2$ button, and I'll assume yours has, too. If not, × followed by = has the same effect. Pick a number between 0 and 1, such as 0.54321, and hit the $\mathbf{x}^2$ button. Do it again, over and over, and watch the numbers. What happens?

They shrink. By the ninth time I hit the button on my calculator, I get zero, and since $0^2 = 0$ it's no surprise that after that nothing very interesting happens.

This procedure is known as *iteration*—doing the same thing over and over again. A differential equation does exactly the same thing, over very tiny intervals of time. Try iterating some other buttons on your calculator. Below, I've always started with 0.54321, but you can use other starting values if you want to. Avoid 0, though. On my calculator, in "radian" mode, after pressing the **cos** button about forty times I get the mysterious number

0.739085133

which just sits there. Again the iteration just settles down to a single value: it *converges* to a steady state.

The **1/x** button does something more interesting: the number switches alternately from

0.54321

to

1.840908673

and back again. The iteration is *periodic* of period 2, that is, if you hit the button twice you get back where you started.

The **exp** button rapidly blows up to numbers so large that they exceed the calculator's capacity: E for error.

Push all the buttons you've got: you'll find that the above—settle to a steady state, become periodic, or blow up —

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seem to exhaust the possible types of behavior.

But is this just because the buttons on a calculator are designed to do nice things? Nature may not be so accommodating. Let's invent new buttons. What about an $x^2 - 1$ button? To simulate it, hit the x^2 button and then $-$ 1 =. Keep doing this. You soon find you're cycling between 0 and -1, over and over again. The behavior is just a periodic cycle. There's nothing more predictable than a periodic universe: watch one cycle, and you know exactly what it will do forever. Imagine the ease of weather forecasting if a given day of the week always had the same weather!

One last try: a $2x^2 - 1$ button. Start with x somewhere between 0 and 1 and equal to neither. Looks pretty harmless, can't see why anything special should happen. Hmmm . . . jumps around a lot. Let's wait for it to settle down. . . . Taking its time, isn't it? Can't see much of a pattern. . . . Looks pretty chaotic to me (Figure 2).

Aha!

A simple equation. But the results don't look so simple: in fact *they look random*.

Now try the $2x^2 - 1$ button again, but start with 0.54322 instead of 0.54321. It still looks random—and after fifty or so iterations it also looks completely different. What you're seeing is a sort of Hyperion-in-microcosm. Deterministic equation: patternless output. Slight change in the starting value: lose track completely of where it's going. What makes this all the more remarkable is that while $2x^2 - 1$ is so weird, the superficially similar button $x^2 - 1$ is perfectly well behaved.

Why is this? The main reason is that the formula $2x^2 - 1$ magnifies tiny differences in the values of x, so that after a certain number of iterations values that started very close together move pretty much independently. Thus the behavior is "unpredictable." The formula $x^2 - 1$ doesn't. It's as simple as that.

Cosmic Potato

Back to Hyperion—but now with a more realistic model. The most familiar shape for celestial bodies is a sphere, or more accurately a spheroid: the Earth, for example, is flattened at its poles by a few percent. Hyperion, in contrast, is an ellipsoid whose principal axes (length,

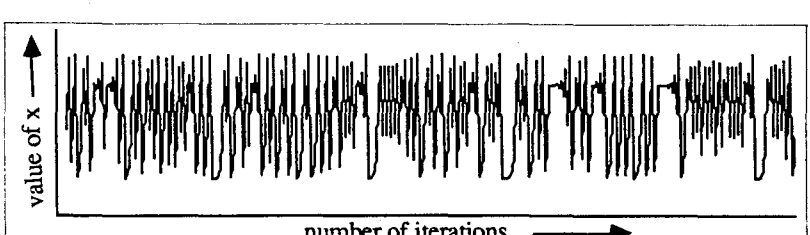

FIGURE 2:
Iterating the $2x^2 - 1$ button. The value of x is plotted vertically, the number of iterations runs horizontally. Observe the lack of pattern.

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FIGURE 3:
Hyperion, the cosmic potato. [NASA].

breadth, and height, so to speak) are 190 km., 145 km., and 114 km. A cosmic potato (Figure 3).

Hyperion's orbit around Saturn is approximately elliptical. The extent to which an ellipse deviates from circular form is measured by a quantity known as *eccentricity*: Hyperion's orbit has an eccentricity of about 10%. This is unusually large for the planets and satellites of the Solar System, but it just means that the orbit is a slightly flattened circle.

Hyperion's *position* in orbit is regular and predictable. You could tabulate it decades ahead and be accurate to a fraction of a second in timing. What makes Hyperion virtually unique among the moons and planets of our Sun is its *attitude* in orbit: the directions in which its three axes point. Most planets roll along like soccer balls on a flat pitch: Hyperion is more like a football bouncing over a battlefield. If you could freeze the position of its central point, and just watch the way it moves relative to that, you'd see it swinging almost randomly in every possible direction.

Both its position in orbit, and its attitude, are determined by the identical physical laws, the same mathematical equations. Its position corresponds to a regular solution of those equations; but its attitude corresponds to an irregular solution. Hyperion's tumbling is due not to random external influences, but to dynamical chaos.

Why is Hyperion chaotic? For that matter, why are all the other bodies regular? Is it the potato-like shape? Are all potatoes chaotic?

Not at all. The reasons are more subtle, more complicated, and much more interesting. Hyperion's chaotic motion is a cosmic coincidence. At various times in the history of the Solar System, other bodies have evolved into, and back out of, a period of dynamical chaos. But it so happens that Hyperion is undergoing this process at precisely the time when the human race has become interested in it.

Vampire Doppelgänger

How does a rigid body move? First, we can pretend that the center of gravity

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of the body is fixed, and deal only with the motion relative to that. Second: the shape of the body is largely irrelevant. What determines the motion is its axes of inertia. To every solid body, no matter how irregular its shape or density, there corresponds an *ellipsoid of inertia*. This is a ghostly companion, rigidly attached to the body but having no mass, and as its name suggests, it's ellipsoidal in shape. The lengths of each axis of the inertial ellipsoid are proportional to the inertia of the body when spun about that axis, so long axes correspond to greater inertia.

As the body moves, so does the ghost: it's a doppelgänger. If the body rotates regularly, so does the ghost; if the body tumbles, the ghost tumbles, too. But now comes a transmogrification. Let the ghost, vampire-like, absorb the material essence of the body, so that we have a solid ghost and an eerie spectral body still attached to it like a living husk. As presently constituted, the newly solidified ghost will tend to follow a different dynamical path from that of the original body, because short axes of a body correspond to long axes of inertia, and conversely—see below. To take care of this we distort the ghost ellipsoid, squashing its long axis and stretching its short axis. We change the sizes of the axes in such a way that it becomes an ellipsoid whose own inertial ellipsoid is the same as that of the original body (Figure 4). (The inertial ellipsoid of an ellipsoid is a *different* ellipsoid in general: fat where the original ellipsoid is thin, and thin where it's fat. Confusing, isn't it? The distortions are there to make the metaphor and the mathematics match.)

All of the mass of the body is now transferred to the distorted ghost. How does the motion change? *Not at all*. The body and its ghost have the same inertial properties; therefore their motion is identical.

In other words, when thinking about the motion of solid bodies, you can confine your attention to uniform ellipsoids. The fact that Hyperion looks like a potato is irrelevant; but the fact that a potato's ghost ellipsoid has three *unequal* axes is crucial.

One of the simplest types of motion

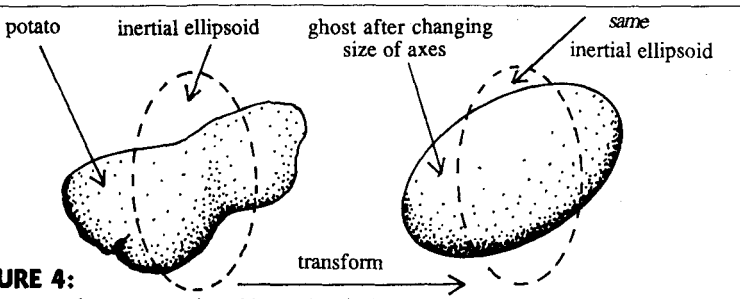

FIGURE 4:
A potato (representing Hyperion), its inertial ellipsoid, and its transformed 'ghost' ellipsoid which has the same inertial ellipsoid as the potato.

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is when the body is spinning about one of its inertial axes. When is such a motion stable? Answer: when the axis is either the longest or the shortest, but not when it's the one in the middle.

You can easily check this experimentally. A book generally has three unequal inertial axes. They run through the central point of the book, buried deep in its pages. The longest inertial axis runs from the middle of the back cover to the middle of the front cover. The shortest runs from the middle of the top edge to the middle of the bottom edge. The third, the in-between one, runs from the middle of the spine to the middle of the vertical edge.

The longest axis of inertia is the shortest axis of the book, and vice versa. That's not a mistake: inertia is greatest where the mass is moving fastest. If you spin the book at a given speed around its shortest physical axis, then the points at the corners of the book are a long way from the axis and so move faster. On the other hand, if you spin it at the same speed about its longest physical axis, the points of the book are closer to the axis and hence move more slowly.

Anyway, get yourself a book. Something heavy (in the physical, not the metaphorical sense) is best: *War and Peace*, or a dictionary. Hold it between the palms of your hands with the title on the spine facing you, and spin it about its shortest axis. You'll have no trouble doing this. Now hold it by its top and bottom edges, with the spine horizontal, and spin it about its longest axis. Again, no trouble. Finally, however, hold it at the middle of the spine and the middle of its vertical edge, and try to flip it about its middle axis. You'll find that it refuses to spin properly and instead begins to twist and tumble. This is because rotations about the middle-sized axis are unstable.

Spin-Orbit Geometry

In 1984 Jack Wisdom, an astronomer at the Massachusetts Institute of Technology, and his colleagues Stanton Peale and Francois Mignard, wrote a paper in the journal *Icarus* with the title "The chaotic rotation of Hyperion." In it, they *predicted* that Hyperion must tumble chaotically. Their analysis, simplified a little, goes like this.

Hyperion's orbit is an ellipse, but it changes slowly. Ignoring this, we can model the satellite's orbital motion by a *fixed* ellipse. The approximation is acceptable because Hyperion tumbles much faster than its orbit varies. Model Hyperion itself by a suitable ellipsoid, spinning about its longest axis; and assume that this axis is perpendicular to the plane of the orbit. We'll see why below. Its tumbling can then be captured by the *spin-orbit* geometry, described as follows. Because we've fixed the direction of the longest axis of inertia, just one further angle will tell us exactly what the attitude of Hyperion is. Namely, we need to know in which direction the smallest axis points. (The middle axis, at right angles to both of these, is thus determined, too.) Call this the *spin angle*. One extra number will tell us whereabouts in its orbit Hyperion is, namely, the angle between its position and some fixed point of the orbit. For

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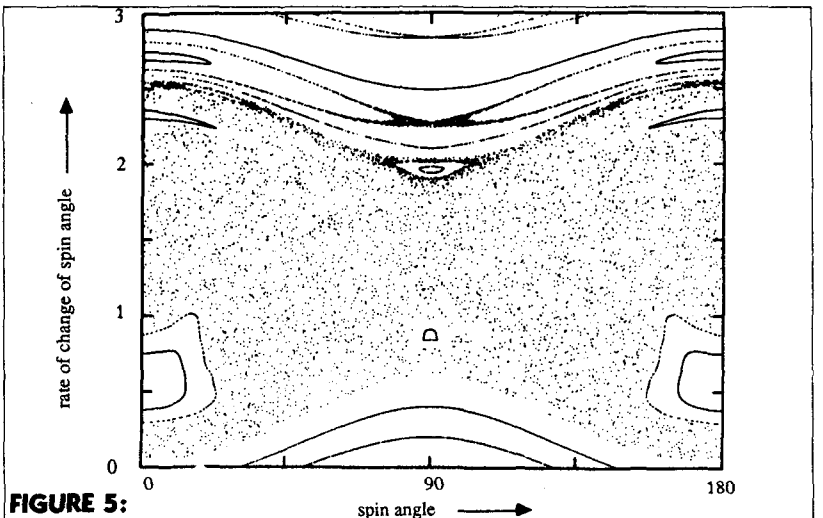

FIGURE 5: Successive snapshots of the motion of Hyperion. The stippled X-shaped region is the chaotic zone. [Jack Wisdom.]

convenience the periapse—the nearest point to Saturn—is chosen as this fixed point, and the corresponding angle is the *orbit angle*, or "true anomaly" in more conventional parlance. The gravitational pull that Saturn exerts on Hyperion depends on this orbit angle, which in turn depends on time; hence the gravity of Saturn can be represented as a time-varying gravitational field of a particular kind.

Anyway, you can write down the equations for all this, and you end up with a simplified mathematical model with three ingredients. One is the spin angle, the second is the rate of change of the spin angle, and the third is time—or equivalently, the orbit angle.

Poincaré's Stroboscope

The equation can be put on a computer, and solved numerically. One version of the result is shown in Figure 5. The variables in the picture are the spin angle, and its rate of change. You'll notice that the time variable is missing. In order to reduce the number of variables, the picture shows a cross-section of the dynamics—a regular sampling, rather like a series of snapshots. Here a snapshot is taken every time a point representing the state of the system passes through this particular plane and all the snapshots are superimposed, giving a kind of "multiple exposure.". The result is a diagram full of dots (one for each component exposure of the multiple snapshot), called a *Poincaré section*, after the great French mathematician Henri Poincaré who invented the technique.

From one interval to the next, the

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point representing the state of the satellite hops from one position in the Poincaré section to another. The picture doesn't show where the point goes in between, but we don't have to worry about that to distinguish regularity from chaos.

The Poincaré section shows a series of closed curves, plus a large X-shaped stippled region. The curves represent regular periodic or almost periodic motion: at each interval the representative point hops regularly around one of the closed curves. The stippled region represents chaotic motion: at successive intervals, the representative point hops around "at random" *over the entire stippled region*. Hyperion might in principle be behaving in either of these ways. But the energy of its motion determines which, and Wisdom and his colleagues showed that chaos is the winner.

Tidal Friction

Saturn's gravitational field also exerts a more subtle influence on Hyperion. Because the force of gravity falls off at increasing distance, Saturn attracts the near side of Hyperion more strongly than it attracts the far side. Among other things, this "tidal" attraction causes Hyperion to revolve around its longest inertial axis, rather than its shortest, even though both would be stable in the absence of Saturn's gravity. Imagine Hyperion in a horizontal orbit, sitting at a tilt, with one side bulging towards Saturn, the other away. Suppose for definiteness that the side nearest to Saturn is tilted below the horizontal. (In space, there's no distinction between "up" and "down," so to use that kind of descriptive language, you have to specify which is which.) Then Saturn pulls a little bit harder on the nearer bulge. This causes the satellite to tip upwards a trifle, bringing the spin axis more nearly vertical. Over long periods of time the effect of the tidal force is to make the spin axis perpendicular to the orbital plane. This is true of all bodies, not just Hyperion.

The process is nicely illustrated by tossing a partially filled bottle of Liquid Paper which is initially spinning about the longest axis. (Make sure the top is firmly screwed on first.) Recall that the longest physical axis—the symmetry axis, along the middle of the bottle from top to bottom—is the shortest inertial axis. You'll find that the bottle refuses to spin about its longest axis (even though a totally full bottle will do so quite happily, just like *War and Peace* did). Instead it twists until it is rotating about the shortest physical axis—the longest inertial axis. The motion of the liquid within the bottle introduces a kind of tidal friction, similar in its effect to the tidal forces that Saturn imposes upon Hyperion. You can use the same effect to distinguish a hard-boiled egg from a fresh one without cracking them open—provided you're good at catching eggs that have been tossed into the air.

This is why the model assumes that the spin axis is perpendicular to the orbital plane. There are other assumptions, too. Fortunately, it can be shown by more careful analysis that once the system is in the chaotic zone, then the

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chaos persists even if the assumptions of the model are relaxed.

Stand up for Chaos

This complicates the picture, but we're finally in a position to see how Hyperion came to be in its current chaotic state.

In the distant past, Hyperion's rotational period ("day") was much faster than its orbital period ("year"). Its motion was then regular and quasiperiodic. Over eons of time, the tidal forces from Saturn slowed its rotation and (as we saw with the Liquid Paper experiment) stood Hyperion up on end, so that its spin axis was the longest inertial axis and this was perpendicular to the orbital plane. However, once Hyperion lost enough energy to bring it into the chaotic zone, the work of millions of years was undone in only a few days. Within three or four orbits, Hyperion began to tumble in all directions.

The same analysis suggests that *all* irregularly shaped satellites must at

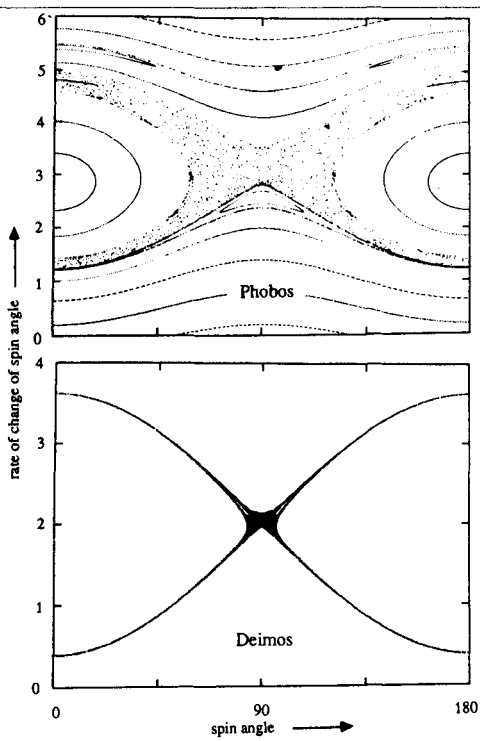

FIGURE 6:
Phobos (above) and Deimos (below) have different sized chaotic zones. [Jack Wisdom.]

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some stage in their evolution pass through a period of chaotic tumbling. Phobos and Deimos, the two moons of Mars, must have tumbled chaotically at some time in the distant past (Figure 6). So must Neptune's smaller moon Nereid.

Resonance

There's more to Figure 4 than just chaos. At the lower left and right, towards the edge of the chaotic zone, you can see an oval "island" of regular motion. This corresponds to synchronous motion, in which Hyperion always turns the same face towards Saturn (as the Moon does towards the Earth). Hyperion might eventually emerge from chaos into synchrony. Other islands can be seen, too; for example, the small one at the top of the chaotic zone corresponds to Hyperion rotating twice in each orbital period. The islands correspond to *resonances*, where different aspects of the motion occur with periods that are in some simple numerical relationship such as 1:1, 2:1, 3:2, and so on. Thus Titan, another satellite of Saturn, has an orbital period that is close to 4:3 resonance with that of Hyperion. Specifically, Hyperion takes 21.26 days to complete one orbit, and Titan takes 15.94. The ratio of these is 1.3337, convincingly close to the ratio 4:3.

Kirkwood Gaps and Hilda Clumps

It is resonances that could at any moment dump the equivalent of a gigaton hydrogen bomb into our back yard. The effect is related to a long-standing astronomical conundrum, the gaps in the asteroid belt. The largest asteroid, Ceres, was discovered in 1802 by Wilhelm Olbers and is about 430 miles across. The smallest are little more than huge rocks. There are tens of thousands of them. Most asteroids circle between the orbits of Mars and Jupiter, although a few come much closer to the Sun. But the asteroid orbits are not spread uniformly between Mars and Jupiter. Their radii tend to cluster around some values and stay away from others (Figure 7). Daniel Kirkwood, an American astronomer who called attention to this lack of uniformity in about 1860, also noticed where the most prominent gaps occur. If a body were to encircle the Sun in one of these *Kirkwood gaps*, then

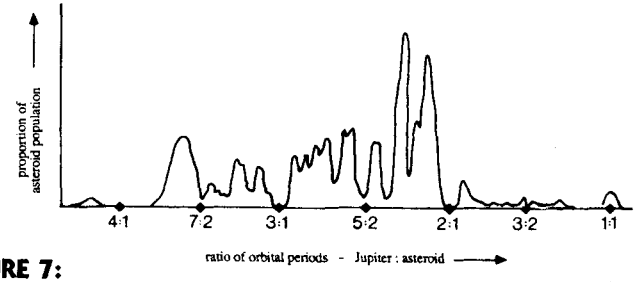

FIGURE 7:
Distribution of the asteroids. There are gaps at many resonances—but a clump at the 3:2 resonance. Why?

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its orbital period would resonate with that of Jupiter. Conclusion: resonance with Jupiter somehow perturbs any bodies in such orbits, and causes some kind of instability which sweeps them away to distances at which resonance no longer occurs. The special role of Jupiter is to be expected: it's so massive in comparison to the other planets.

The gaps are obvious in recent data, especially at resonances 2:1, 3:1, 4:1, 5:2, and 7:2. On the other hand, at the 3:2 resonance, there is a *clump* of asteroids, the Hilda group.

Resonances have been used by astronomers as something of a catch-all. The Moon always faces the Earth, a 1:1 resonance between its orbital and rotational periods. Mercury takes 88 days to revolve once round the Sun, and 59 days to rotate once on its axis. Two-thirds of 88 is very close to 59, so Mercury's orbital and rotational periods are in a 2:3 resonance. These resonances are presumably stable (or else the bodies concerned would never have got into such a relationship). So the stability of the resonances "explains" the observed phenomena.

But for the asteroids, apart from the Hilda group at 3:2, the explanation appears to be the *instability* of resonances! Clearly the only way to resolve this difficulty is to work out the mechanism of instability: presumably it is different in each context. Further, there must be something unusual about the 3:2 resonance, which explains the Hilda group.

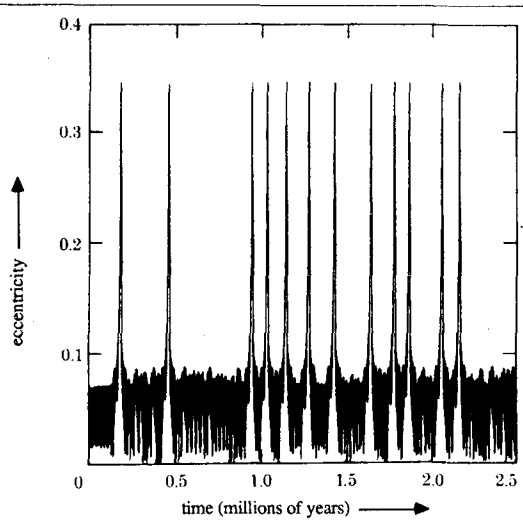

FIGURE 8:
Random spikes in the eccentricity of an asteroid in 3:1 resonance with Jupiter. [Jack Wisdom.]

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Eccentric Spikes

Until recently neither analytic nor numerical methods were capable of performing a sufficiently long-term analysis of these resonances. But more powerful computers and new theoretical principles now exist, and the 3:1 resonance, at least, is pretty well understood.

The calculations show that an asteroid, orbiting at a distance that would suffer 3:1 resonance with Jupiter, can follow a very irregular path. Indeed, the eccentricity of its orbit can change violently and almost at random (Figure 8). This is another astronomical example of dynamical chaos. The irregularities happen on a timescale that's short by cosmic standards, but long by computational standards: about ten thousand years. To see what's *really* happening requires much larger timescales, covering millions of years. A typical chaotic trajectory then exhibits bursts of high eccentricity, interrupted by periods of low eccentricity, with occasional high-eccentricity "spikes." A body in such an orbit will follow a roughly circular path when the eccentricity is low, but a much longer and thinner elliptical path when the eccentricity is high.

Martian Sweeper

How does this account for the 3:1 Kirkwood gap?

In a burst or at a spike, the asteroid's

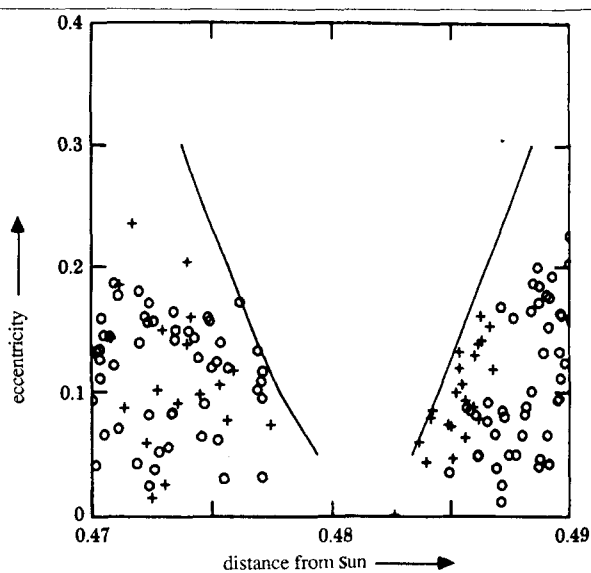

FIGURE 9:
Theoretical boundary of the 3:1 chaotic zone compared to the actual distribution of asteroids. [Jack Wisdom.]

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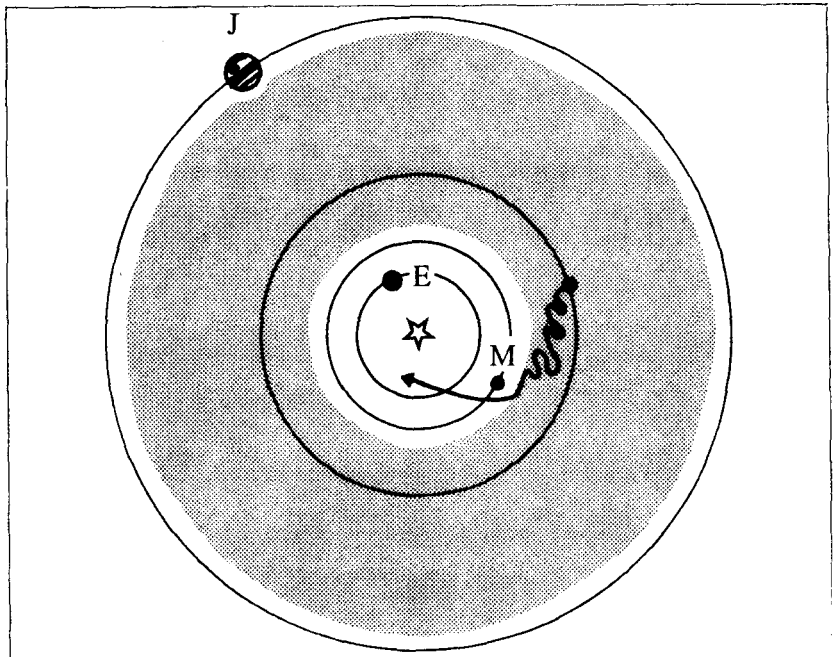

FIGURE 10:
How Jupiter and Mars can transport asteroids into the Earth's orbit.

eccentricity increases. It turns out that an asteroid whose orbit has eccentricity 0.3 or more becomes *Mars-crossing;* as you'd guess, this means that its orbit crosses that of Mars. Every time it does so, there's a chance that it will come sufficiently close to Mars for its orbit to be severely perturbed. An asteroid that crosses the orbit of Mars often enough will eventually come too close, and be hurled off into some totally different orbit. A comparison between the boundary of this 3:1 chaotic zone, and the actual distribution of asteroids, is strikingly good (Figure 9).

Until it was realized that chaos could generate high eccentricity, Mars-crossing was not a plausible mechanism. Asteroids around the 3:1 Kirkwood gap were expected to stay well clear of Mars: there was no reason to expect a sudden change of eccentricity. But now there is such a reason, the mathematics of chaos. The 3:1 Kirkwood gap is there because Mars sweeps it clean, rather than being due to some action of Jupiter. What Jupiter does is create the resonance that causes the asteroid to become a Mars-crosser; then Mars kicks it away. Jupiter creates the opening; Mars scores a field goal.

Or maybe a touchdown.

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Mars might just kick the asteroid in our direction (Figure 10). The 3:1 resonance with Jupiter can transport rocks from the asteroid belt into Earth orbit, to burn up as meteorites in our planet's atmosphere.

And, if they're big enough, to burn us up instead.

It's a sobering thought. Newton's beautiful, regular, clockwork laws are the rules for a random football game, played out by Mars and Jupiter on a cosmic battlefield. This game determines whether or not life continues to survive on Earth. Newton thought he'd ruled out divine intervention, but the unruly gods of the *Enuma Elish* are alive—and kicking. The chance that this celestial version of Russian roulette will prove fatal is admittedly very, very tiny—but it's there. The Solar System is—literally—dicing with death.

Ours.■

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●I would offend with the truth than please with adulation.

Seneca
submitted by John Hradsky

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The Plexiglas of the bus window cool against his cheek, Neil Aebits drowsed and mused and absent-mindedly admired the way autumn spattered the city with glorious reds and delicious golds. New Haven seasons used a palette vivid enough to electrify—perhaps to compensate for the grey-bellied clouds that hung overhead so often that a glimpse of blue sky evoked astonishment.

Aebits would have traded all the brilliant foliage in all New England for two days of uninterrupted sunshine. He missed his own place and time. He wished his research were done so he could go home.

The heavy diesel engine at the back of the bus throbbed, then growled around the corner onto Temple Street.

A woman stood beside the bus stop's Lexan shelter, letting the wind tease her golden hair and flatten her denim skirt against her thighs. She was laughing at a street mime. Head thrown back, face aglow with delight, she throbbed with a joy, an energy, far too large for her small frame to contain.

It hurt just to look at her. Some things did that to him. Mountain sunsets. Rainbows over misty rivers. Fiery azaleas beaded with dew. The elegance of such things panged his heart because, knowing the ephemerality of pure grace, he ached to preserve the scene in its magic entirety, even as he knew that time would sweep the moment away, leaving nothing for him but a memory to recall with wistful, poignant longing.

Neil Aebits fell in love.

All the while he fell, he realized the absurdity of it. Love at first sight? Without talking, without touching? Impossible. Lust, yes. Beauty as vibrant as hers could provoke that easily. But not love. That would be ridiculous.

He pushed his nose against the window. He sighed. No, not lust. Lust raced his pulse, dried his mouth, and warped his judgment. This did none of those. It just hurt.

It hurt almost as much as his certainty that when the currents of time swirled them off in different directions, he would make no attempt to find her. How could he? By stepping back to 1995 New Haven, he had become a character in a movie filmed 500 years before his own birth. History had written the script; time would ensure that he spoke his lines on cue. He wished he knew how the story ended.

The woman stood ten feet from a pole-mounted ID reader. He wanted to know her. To his pleased surprise, time moved his hand and made it pinch the pressure switch imbedded within his right earlobe.

The "voice" of his personal operator filled his skull: *Yes?*

Do you see that woman? He focused on her so the pers/op, with its tap into his optic nerve, would get a clear image.

Yes.

Find out everything you can about her. Have a preliminary report ready for me by this evening.

The pers/op stayed silent for two full seconds before it said, *Request permission to acquire data illegally.*

The bus pulled away from the curb. He craned his neck, keeping the woman in view. He had never seen her before, but he wanted to see her forever more. The future, apparently, flowed the same way. *Permission granted.*

* * *

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Zombie puppet of the far future, Aebits strolled to his broker's office. Time shepherded him along by solidifying the air outside his prescribed course—not literally, but it felt like that. If he moved too slowly, air seemed to congeal at his back to thrust him forward; too quickly, it would thicken before him like molasses.

Halfway up the block, brakes squealed. Van doors banged open. "Tree killer!" Four masked figures in green jackets leaped out and threw a well-dressed old man to the sidewalk.

"Hey!" The sudden brutality of the attack outraged Aebits even as it bewildered him. "Hey!" It took him a second to link the masks and green jackets to the terrorist eco-freaks of the lunatic left. "Leave him alone!" He surged forward to help the old man. Invisible resistance stopped him.

Two of the Green guerrillas pinned their target's thin shoulders. The third stole his copy of the *Wall Street Journal,* and the fourth carved a bloody "TK" on his lined forehead. Springing to their feet, they jumped into the van and sped away.

Time released Aebits, then, but a puffing, red-faced street cop reached the old man first, so Aebits passed by in silence.

The first flare of anger receded, leaving him chilled, jittery. The Greens had gone mad. In the past they had dynamited coal mines, torched printing plants, and sabotaged refineries. Now, apparently convinced they were losing their war against environmental abuse, they were striking at consumers, hoping to intimidate them out of buying products the Greens deemed reprehensible.

With Greens on the left, Jasons on the right, and junkies, muggers, and just-plain-crazies in the middle, the streets frightened Aebits. He wished time would let him hide in the library until he had finished his research. He wished time would introduce him to the laughing woman. He wished—

The doorframe ID reader at his broker's office halted him, found his card's emission pattern on the approved-for-entry list, and let him into the lobby. A woman—a Jason vigilante, from her JSN armband and "Just Say No" T-shirt—tried to slip in behind him. The doorframe dropped her with an anesthetic dart.

He had no sympathy for her. The shock troops of the radical right treated individual rights as contemptuously as the Greens did economic rights. Self-appointed guardians of international morality, they, too, had adopted ever more extreme tactics as their public appeal diminished. They held one advantage over the Greens, though: the tacit support and approval of law-enforcement bodies worldwide.

Time propelled him into a plush chair before the brokerage's ticker. Time would hold him there for the next hour, constantly tweaking the muscles of his face into an expression of appropriate interest.

His true interest centered on the laughing woman. His pers/op would have a dossier on her by nightfall. Would time let them meet? He prayed it would, for his need to know her ached like a wound. After-images of her face floated through his mind; he imagined the tone and timbre of her voice, and the texture of her skin beneath his hand.

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A chair creaked. The scent of fruity after-shave washed over him. "Good morning, Mr. Aebits."

"Good morning, Doctor Krine." He extended his hand to the dapper pixie at his left. "You got some sun, I see. Florida?"

"A tanning booth at the club, Mr. Aebits. Too many armed Jasons in Florida." He nodded to the ticker. "3M's up another point."

"I called that one wrong," said Aebits. "I got out Friday." Of course he had. He could not wring the maximum profit from his every position without drawing the regulators' attention. So the pers/op aimed for half maximum, deliberately buying long after a stock had rebounded from a low, or selling well before a high. . . . very easy to achieve, for a computer supplied with five hundred-year-old records.

Odd, that this society took great pains to preserve its financial data, yet would never make a permanent record of its artistic and literary accomplishments. The vaults in the mountains brimmed with computer tapes and optical disks imprinted with the minutia of daily economic life, but the histories, the tragedies, the comedies—they would vanish in The Collapse.

Hardening air at his back began to ease him out of the soft chair. He pressed his earlobe.

Yes?

Any trades today?

No.

He stood and held out his hand to Dr. Krine. "Tomorrow?"

"As ever, Mr. Aebits."

As Aebits crossed to the fiction section of the New Haven Public Library, the head librarian was telling a green-jacketed woman, ". . . will *not* surrender any book not available electronically. Biblioclasm is not symbolic action! If you can't transform a book into a tree, then your eco-terrorism—"

Aebits slowed to eavesdrop longer, but time shoved him into a narrow aisle between high shelves. He pinched his earlobe. *Enter scanning mode; run Program Reprint.*

Scanning.

Again starting at the A's—lest he miss any recent returns—he skimmed the rows of clothbound spines.

Midway through the H's, the pers/op fed his optic nerve an image: **Catch-22.**

Aebits took it to the nearest table and opened it.

Request permission to correct errors of spelling, punctuation, and grammar.

Permission denied. The literature departments might wish to salvage what an author had really meant or hoped to say, but this was Aebits's thesis project, and he had dropped back five centuries in order to determine what the reading public had actually encountered.

He believed that the root causes of The Collapse lay in the amount, variety, and inconsistent ethics of late 20th Century fiction. A viable society, after all, must share values and ideals, and those concepts must govern more than the side of the street on which to drive. When a culture cannot even decide the morality of murder. . . .

He flipped through the book, glancing briefly at each page. The pers/op captured every image and fed it to the

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program for translation into one continuous text file.

Aebits planned to carry the nanofloppies home, but in case his paper trail through this era ended because of death and not departure, Program Reprint would back him up. That evening, through the inconspicuous gamma-ray laser on the rooftop, it would transmit that day's readings. Five centuries later, an antenna on a literature department space station 500 light-years from Earth would vibrate to words lost for half a millenium.

Whether dead in the 20th Century or alive in the 25th, Aebits would have enriched his era's culture by filling another gap in its amnesiac memory.

Cold metal encircled his neck and tightened almost to the choking point. "Gotcha, junkie!" said a young man's voice. "What are you on?"

While Aebits tried to breathe, the Jason came around the table. Twentyish, with fanaticism in his blue eyes and a Nancy button pinned to his "Just Say No" T-shirt, he grinned in nervous triumph.

"Nothing." Aebits trembled with rage. He wanted to claw at the testing collar, but knew the device wouldn't unlock until it had found him free of drugs, certain antibodies, and illegal levels of assorted hormones.

"Ri-ight, you're doing a page a second and you're not on drugs." His eyes widened abruptly. "You're looking for the dirty parts, you pervert!"

"No, I'm not! I'm a speed reader. A scholar. And a karate expert." The collar popped open with an audible click. Aebits removed it and tossed it to the Jason. Time prevented him from doing anything else but glaring at the boy.

The Jason paled, and fled.

Neil Aebits had just begun the pers/op's report on the laughing woman when the doorbell rang. With a grunt of displeasure, he blanked the IBM's screen and walked through the living room. He opened the door.

And there she stood, as though she had come to provide the third dimension to the dossier's flat phrases. Michelle Forquet, age thirty-four, born in Montpelier, Vermont on 18 June 1961. Blonde hair (a silken fall to her shoulders, where it curled in and up), green eyes (flecked with gold, the whites clear as fine porcelain), five-foot-six (if he held her his lips would brush her hairline), one hundred thirty pounds (in the denim skirt and a navy sweater almost, but not quite, too small for her). A trim leather purse hung from her left shoulder by a long strap.

Stunned, he could not even open his mouth.

She smiled shyly at him.

Oh, God, it hurt to look at her. Dazzling in the doorway of his run-down apartment, she graced the time and the place with her presence. His world would dim unbearably when she left.

She gazed straight into his eyes. "May I come in, please?"

Bliss exploded through the shock and the ache with such intensity that it frightened him. Lightness filled him, and threatened to hurl him into the ceiling. If he tried to speak, elated, giddy laughter would peal forth. He could not handle it. He could only step back, and gesture her into his shabby living room.

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"Thank you." Her whisper burned his ears. As she passed, her perfume swirled in his nostrils, intoxicating him with its richness, its promise.

He let out his breath and closed the door. When he turned, he found her taking a cellular phone from her purse—and then a gun. He gawked.

Setting down the phone, she held the gun with both hands as she aimed it at his torso. "What happened to Chicago?"

His mouth fell open. *Chicago?* He had no idea what she was talking about. Panic bubbled up in him. Words spilled out: "The Cubs? They lost to the Mets, 9-3. The Sox play tonight in Anaheim."

She shook her head slowly. Some of the luster faded from her eyes. "I'm sorry, Neil. That's the wrong answer." Biting her lip, she pulled the trigger.

The bullet leaped toward him. For an instant he thought a sudden surge of adrenalin had altered his senses, enabling him to perceive events in slices cut too thin for the unenhanced nervous system to notice. When the bullet began to glow, he realized that time itself had intervened.

Michelle Forquet gasped. The bullet stopped, and drifted down through the wall of congealed air like a bottle falling to the bottom of the sea.

So. He was safe. The present could not alter the future's established past—and exhumed brokerage records proved he would play the market until The Collapse. He shivered once.

The bullet settled gently to the carpet. Michelle made a noise of exasperation. Her hands shook badly; she lowered the gun.

He cleared his throat. "Um . . . may I get you something to drink?"

Aebits poured excellent brandy into a K-Mart tumbler. "Here."

Michelle hesitated before taking it. "But your neighbors heard the shot. Won't—"

"They won't call 911 unless they hear more shots, or screams, or the thump-thump of a body tumbling down the back staircase."

"People." She grimaced, then sighed over the brandy's bouquet, and took a long swallow. Her green eyes watered. She gave a soft, polite cough. "What line are you from?"

"Line?" he said blankly.

"Branch? Continuum? Parallel world?"

The words buzzed in his ears like static, noisy and meaningless until, almost intuitively, he understood their implication: Michelle came from an alternate America, from an Earth with its own unique history—and thought he did, too.

This would choke the chronocrats, the temporal engineers of Aebits's era who claimed that the present flowed inexorably to a single future. They were wrong. The time stream *did* branch; one *could* leap sideways. He began to stall. "Why do you think I don't belong here?"

"Don't play the naif. For one thing, you haven't called the police. And your software's too good for this line." Moving to his second-hand sofa and sitting down, she stared moodily at the bullet on the carpet. "So's your flak jacket. A mega-improbability projector?"

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"What do you mean my software's too good?"

"My lookout program monitors the nets. It caught you pulling my past without alarms, audit trails, or wasted time. Slick, real slick. Nobody's got software like that except us." She smiled, but not with delight. "And, apparently, you. So what line—?"

"Why did—" *I even for a minute think you were at my door because you had seen me as I had seen you, and you wanted me every bit as much as I want you?*—"did you come here tonight?"

"You're not going to answer, are you?" Her head fell back against the sofa's grimy cushions. She looked appallingly, appealingly vulnerable. "I need to borrow your hopper. Please. I'll return it in twenty minutes."

"What's a hopper?"

"The device that carries you from one line to another. What do you call it?"

"But you shot at me!" The words burst out without hostility—he felt none for her and did not think he ever could—but with amazement that she could ask a favor of someone she had just tried to murder.

"Neil, I—I'm sorry. It wasn't personal. Personally, I'd rather—" She flushed, and looked away. "I have standing orders. Whatever it takes. I have to keep other hopping lines from finding out about ours no matter what I have to do."

"And you knew I'm not from your line because—what *did* happen to your Chicago?"

"The Rhodies nuked it."

Every answer triggered more questions whose answers only confused him further. "Why do you need a hopper? Where's yours?"

"In my basement." She held up a hand. "I can't go home. A neighbor, an ex-Green, called this morning to tell me a hit-team's watching my house. See, I support myself here as a freelance photographer. It lets me go anywhere. I was up on a rooftop shooting the city by dawn when the Greens burned the *New Haven Register* building. I called the police, then got four rolls of the arsonists in action. Twelve printers and reporters died. My pictures and testimony helped convict seven Greens of first-degree murder. So they want to kill me to intimidate future witnesses."

"The police—"

"—will stand guard while I collect my stuff, but they'll get nosy when I take the hopper out of hiding, assemble it, and warm it up. So I need to borrow yours. Otherwise I'm stuck here. Please? I'm desperate."

"What made you testify? Not respect for human life, obviously."

She slapped the couch in embarrassment or anger or both. Dust rose. "To null out this line's probability that the Green-Jason Coalition will control Congress after the elections—do *you* want to follow a branch leading straight to the collapse of civilization?"

Even after pouring each of them another brandy, Aebits still flinched at the thought: *Congress caused it?* Oh, God, there went the core hypothesis of his dissertation. "The public *hates* the Greens and the Jasons. Neither party can possibly win enough—"

"They win some, they buy more, and

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they frighten the rest. They will control Congress."

"But what makes you so sure *Congress* will trigger a collapse?"

Michelle gave him an odd look. "The probability compass on the hopper—does yours work differently?"

An insistent knock rattled the door. "Excuse me." Picking up the bullet, he pocketed it, then looked through the peephole.

Four men and three women—all in their mid-thirties and all wearing Nancy buttons—stood in the hall. One lifted his foot, apparently to kick in the lock.

Aebits opened the door a crack. "Yes?"

The mustachioed Jason in front said, "We heard a shot. Your neighbors say it came from here. Are you watching a V-rated film?"

The vigilante's nosiness annoyed him. "A vio-flick? No way."

"Then you won't mind if we check. Ralph? Ted?"

The two biggest men lumbered forward, dipping their shoulders as if to shove against the door. Angry, Aebits nearly resisted, but Jasons on a hunt would smash his door to toothpicks if he refused to open it for them. He stepped aside and let them in. They stank of sweat and gunpowder.

Mustache followed. His eyebrows quirked at the sight of Michelle. "You two married?"

"You're trespassing." Aebits pointed to the hall. "Get out!"

"Test 'em both." Mustache turned to the other four. "Betty, run the sniffer. Dave, check records, tapes, and discs. Jean, books and other paper. Sandy, the computer."

Aebits swallowed an angry protest as Michelle said "Easy," and Ted cocked his fist. Aebits could take Ted, and perhaps the second muscleman as well, but not all seven at once. He let the burly Jason clamp the testing collar around his neck and folded his arms in disgust.

The woman with the detector emerged from the kitchen. "Nada. Handgun in her purse. Registered. One stale marijuana flake, maybe a milligram, on the fire escape. Could have come from anywhere."

The man scanning the bar codes on the VCR boxes said, "All clean here, too. Want me to spot-check, see if the contents match the labels?"

As Mustache shook his head, the testing collars popped open. Ted collected them, and patted Aebits on the shoulder.

Jean staggered into the living room, a large canvas satchel in either hand. "Dirty books! Mailer, Robbins, Nabokov, Salinger—a whole bag full."

"Tsk-tsk," said Mustache. "What's in the other bag?"

"The rest of the paper—we're still synergizing with the Greens, right?"

"Synergizing? We're sinner-chas*tiz*ing with them. They take porn, we take paper." Mustache cupped a hand around his mouth. "Sandy?"

Strolling out of the bedroom, she slid a disc into her hip pocket. "Cleansed."

"Cleansed?" Sick dismay hollowed Aebits's stomach. "You erased my thesis notes?"

Sandy narrowed her eyes. "The program only deletes files containing language found immoral or obscene by either the Just Say No Movement or the Green Earth Now Party."

Aebits nearly went for her throat.

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"The Greens think 'chainsaw' is an obscene word—and *you* idiots want to forbid anything that might be a slang term for a drug, like 'horse' or 'snow' or 'pot.' Not to mention words like 'hump.' "

She slapped him.

"I'm calling the cops."

Mustache flashed a bleak smile—and a badge. "I'm off duty, but I'll escort you to the station so you can file a complaint."

Synergizing? And the Greens want Michelle? "Get out."

"We're going." Mustache paused to stare at Michelle Forquet as though trying to remember something important. Then he shrugged and left.

Synergy. As in a binary gas weapon whose true lethality emerges only when its two separate components combine. Aebits shuddered. No wonder this civilization would collapse. And no wonder only financial records would survive.

Time used Aebits like a ventriloquist's dummy, working his tongue without his permission, unnerving him with the things it made him say and do. "The guy with the mustache will remember why you looked familiar, and he'll tip off the Greens. Do you have a car?"

"No." She slapped her right fist into her left palm. "Damn!"

He could not choose his words, so he tried to inject all he felt for her into his tone. "Can you drive?" Time clipped his emotions flat. He wanted to shout *It's not me talking to you like this; I love you!* but the declaration stayed in his heart and never came close to the air. He could do nothing. He could only read the lines written for him as he came to them, and wait for the resolution.

"Of course I can drive." Surprise put a question in her voice.

"Good." Nearly solid air lifted his hand to her arm. "Let's go."

"Where?"

"Your place."

She resisted. "Aren't you going to lend me your hopper?"

He pulled. "Come on!" Time had not explained it to him, either.

"But, Neil—"

In the autumn night, a chill wind shivered the trees; leaves chattered down the sidewalk. He led her to the parking lot behind the corner restaurant. "Give me your gun."

Biting her lip, she gave it to him.

Aebits showed the gun to a man getting into a brown Dodge. "Excuse me, sir, we need your car. The department will return it to you."

The man backed away slowly, hands in the air.

Michelle slipped behind the wheel, hesitated, then unlocked the passenger side door. As Aebits slid in, the man spun, ran, and screamed.

Aebits said, "Go directly to your place."

"The Greens—"

"When did they show up there?"

"This morning. About ten. I told you, a neighbor called—"

"What time did you leave for work?"

"Eight A.M."

"Good. Drive." He squeezed his earlobe.

Yes?

I'll need to reach 8:05 this morning in two strides. Set the controls; go on my command.

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Yes.

Oncoming headlights flickered through the car. In the distance, a siren wailed, but it did not find them. He sat silent for fifteen minutes, aching to talk but denied his voice, while she navigated the interstate and then a maze of side streets.

"Now what, Neil?"

"Park across the street from your house. Stay put." He switched off the dome light. Marionette-clumsy, he got out, walked around the car, and opened her door. He pinched his earlobe.

Yes?

Go when I turn around.

Yes.

"Michelle, put your left arm around my neck. Hang on tight." When she did, he scooped her up. One breath of her perfume and his knees went weak. Stumbling backward, he pivoted.

A streetlight bathed her face in harsh white glare. A man with an Uzi ran toward them.

Fear parching his mouth, Aebits took two steps. The pers/op triggered the timewalker in his shoes. The light softened into that of an overcast morning.

He did not need to hold her any longer, but she felt so good in his arms—so warm, so solid, so wonderful—that he could not let go of her, and was not required to. Nor did she request him to. He carried her to her door.

As she let them in, he awoke the pers/op. *Return to moment of departure on my command.*

Yes.

"It's 8:05 this morning. Get your hopper together and get out of here." Hardening air nudged him to her sofa. It made him take three cushions and cradle them against his chest. It pushed him into her vestibule.

"Neil—"

Time let him say, "Goodbye, Michelle," with all the yearning in his soul, then forced him back into the cloudy morning.

Halfway down Michelle's walk, appalling insight halted Aebits: Time had sculpted the sofa cushion *trompe l'oeil* to force the assassin to react and branch the line.

Air gelled behind Aebits. He leaned against it, braced his feet, and pushed. If he submitted to the press of time, he would return to that moment beneath the streetlamp.

The running gunman—Uzi already leveled at someone carrying cushions that had briefly resembled a woman — would fire and not fire simultaneously. Binary actions and cascading consequences would spawn alternate futures with the abandon of a supernova throwing off heavy elements.

Aebits had to live, because a thousand separate documents proved he would continue to trade stock for at least six more months.

He had to die, because some lines would not collapse, for his death would discredit the Greens while leading to the arrest and imprisonment of their most radical members, thus eliminating their threat to civilization.

He had to live, because the Green-Jason Coalition would accumulate more popularity, influence, and power—and capitalize on the mysterious disappearance of the witness against them.

He had to die, because only blood on the streets would keep this world from

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walking into the future that would become his past. Denied Michelle's blood, time would spill Aebits's.

His shoes began to scrape on the concrete as the inexorable force increased. He gritted his teeth. He would *not* go forward. If he did he would die, yet he would also live until the very instant of The Collapse, and he did not want to walk either line.

He took a deep breath, gave a weightlifter's grunt, and thrust backward with all his might. He had never fought time so hard before. He had never had such reason. Rainbows formed on the periphery of his vision; his muscles cried for relief. He asked them to give more than they ever had.

He hurt in every limb, every muscle, every cell. A great red noise filled his brain, his mind, blotting out everything except the primal litany and response: *You will. I won't.*

Time tore him in half.

Sprawled on Michelle's lawn, he watched himself stagger to the street and vanish halfway across. He listened closely. Automatic weapons fire? The shriek of a gut-shot time traveler? He shuddered. Leaves tumbled up to him, as if offering cover. He brushed them away and rose.

Inside Michelle's house, he replaced the sofa cushions, then found Michelle in the basement, snapping green plastic tubes into a large octahedron. She looked capable—determined—desirable. He swallowed hard. "Hi." He felt awkward, and unaccustomedly free.

She raised her head. A strand of golden hair hung before her left eye. She brushed it away. "You're back."

"Yes." Her voice had held surprise—had it also held joy? He hoped so. "I'm back. In more ways than one."

"Did you forget something?" She said it softly, gently, as though trying to calm a skittish horse.

He nodded, and pointed to the hopper. "Does that carry two?"

The corners of her mouth tightened briefly, then relaxed, and even curved up a bit. "It can." Her eyes slitted—not, he thought, with hostility, but in assessment. "Why?"

"Is there a line where the Jasons have compassion and the Greens love people as well as trees? And where the Sun shines so often it's boring?"

Catching her lower lip between her teeth, she nibbled it. "A lot of lines fit that description." She glanced away. "Shall I drop you off in one?"

"You might even think about staying there with me."

"No, Neil, I won't." She looked back, then smiled that same wondrous smile that would cause him such blissful pain when he first saw it through the bus window. "And I will." ■

●If you think you can do something—begin it.

Goethe
submitted by John Hradsky

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futures

Matthew J. Costello

Recently, a friend of mine brought me to a meeting of a local professional writer's group. Somehow, during the meeting, the subject of religion was mentioned in passing. . . . a joking kind of reference.

And another writer, a pro of many years experience declared that he was an atheist. I looked over at my friend. Now, I knew that she had recently experienced one of those transcending religious experiences that seem to forever elude me.

And I thought, sitting at that small table with these two people—the dedicated atheist and someone who felt they've been touched by the deity—about the tremendous gulf between them. They were both intelligent, highly-skilled people. But, man-o-man, what a yawning abyss between their world views.

Which is my way of talking about the recently released film, just out on video, *The Seventh Sign* (RCA/Columbia Home Video) While not sui generis, the film is very special genre release. *The Seventh Sign*, an apocalyptic, supernatural film, stars Demi Moore, Michael Biehn, and Jurgen Prochnow. Directed by Carl Schultz, I popped it into the old VCR just to pass the time. The film disappeared quickly at your local googolplex, and—despite encouraging word of mouth from people whose opinion I respect—I didn't expect much.

Who could, looking at the cinematic junkola pushed at the easily pleased fans of the genre?

At first, the film seemed like a moody reworking of *The Exorcist* and *Rosemary's Baby*. At the film's opening, we see a tall, blue-eyed man grimly walking through scenes of great calamities—a beach filled with dead fish, a river turned to blood. At the scene of each odd disaster, he breaks a seal on an ancient parchment. These are, we learn later, signs of the end of the world. And—we wonder—is this man the devil? An avenging spirit?

Then, he becomes a boarder at pregnant Demi Moore's and Michael Biehn's garage apartment. (We learn that Moore's character has had trouble with other pregnancies, the scars on her wrists hinting at the depth of her despair.)

And slowly we begin to understand that the final sign, the one that will end everything, will be the birth of Moore's child. For the well of souls will be empty. . . .

OK, so far there's nothing terribly unique about the film or its premise. Other signs occur—a hail storm, a desert city (on the site of old Sodom) buried in a freak blizzard, and Moore begins to fear the stranger. With the help of a young nerdy biblical scholar, she starts to understand that more than her baby is in danger. Only if one sign is stopped—if hope is allowed to live among the death and despair of our terrorized world—can the end be prevented.

The well of souls is empty. And she

(continued on page 177)

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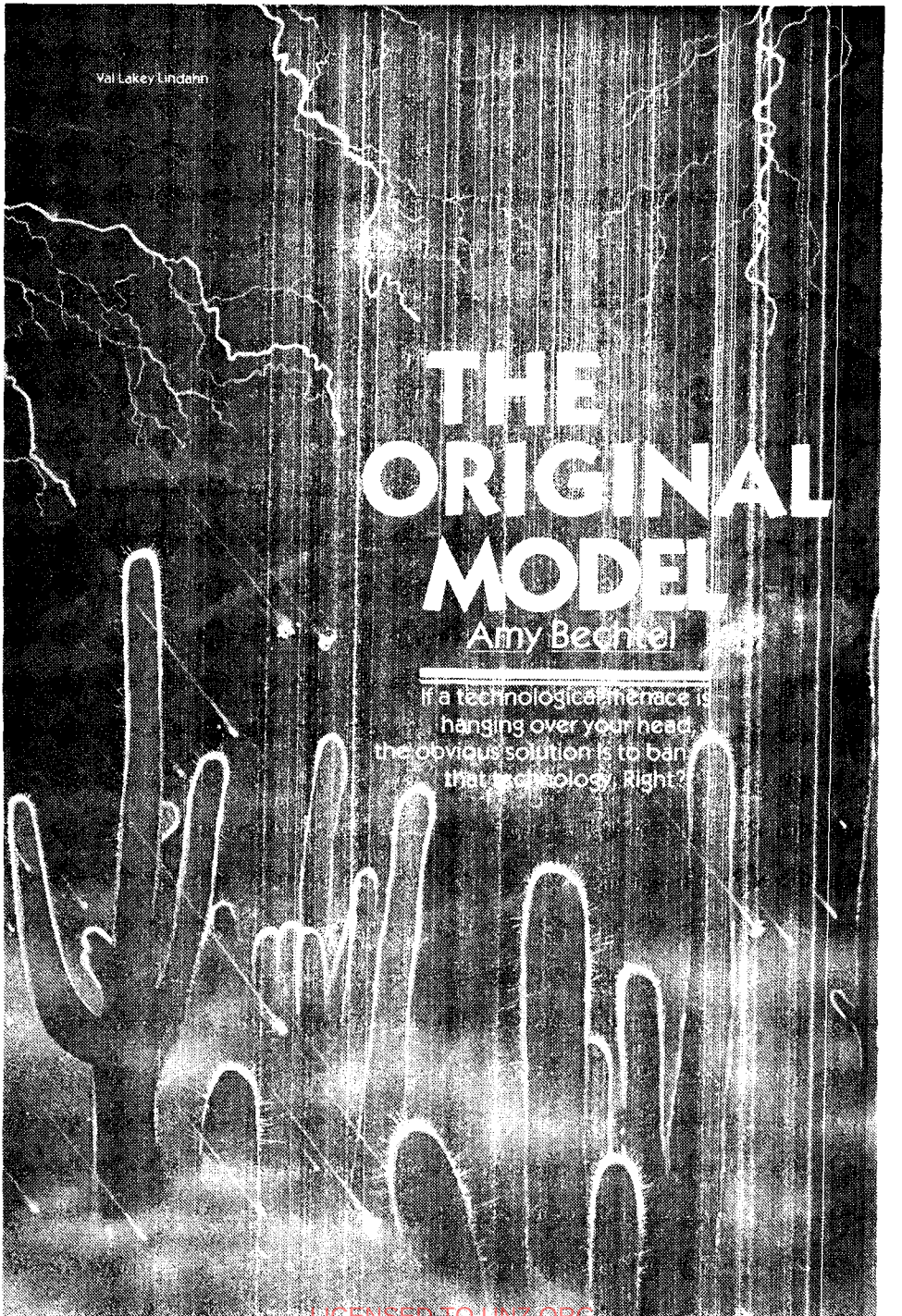
Val Lakey Lindahn
THE ORIGINAL MODEL
Amy Bechtel
If a technological menace is hanging over your head, the obvious solution is to ban that technology. Right?

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Devon still had one more delivery to make when she saw the storm coming in over the mountains. The clouds were dead black, garishly lit from below with flashes of lightning; a low rumbling growl of thunder echoed through the canyons. A cool breeze swept down from the heights and Devon felt moisture in the air; the temperature seemed to have dropped from the nineties to the seventies in a matter of seconds. Her horse, Rabbit, flung his head up, sniffing the air, and Devon steadied him and brought him to a halt.

She glanced back at the saddlebags: two letters and a small parcel for the Lichtenbergs were all that remained. She'd already finished the rest of her route. She could deliver the Lichtenbergs's mail tomorrow and give them apologies and a discount; that would be the sensible thing to do. She ought to go straight home and take shelter. But Rabbit danced beneath her, pulling at the bit and eager to go, and the storm filled Devon with excitement, and Rabbit was, after all, the fastest horse in the region; she had the prize money from last week's race to prove it. She loosed the reins and leaned low on Rabbit's neck, and he broke from standstill to gallop like a rocket.

The road narrowed and dwindled on the way to the Lichtenbergs's, becoming overgrown, and the final turnoff was scarcely a path. The Lichtenbergs didn't go out much; Devon was the only one who used the path regularly. She even brought the monthly groceries. Where the money came from she had no idea, but they always paid on schedule and seemed to have a bottomless supply of cash. Some of the return addresses on the mail were foreign, which made Devon nervous, but so far she had resisted the impulse to hold the letters up to the sunlight; she had a feeling she was better off not knowing what was inside the envelopes.

The light was gone by the time Rabbit pulled up in front of the house; the sun had disappeared behind an enormous roiling cloud of dust. The mountain peaks had vanished also. Devon pulled the mail out of the saddlebags and jumped down to bang on the door. Mrs. Lichtenberg answered it, looking surprised.

"Why, honey, I thought you were the wind at first. And I thought that stuff about sleet and wind and hail was just for the regular U.S. mail."

Devon handed over the mail and smiled weakly; Mrs. Lichtenberg made her uncomfortable. "Swift's Pony Express and Air Mail always tries to please its customers, ma'am. Excuse me." She ran for her horse and cued him to a gallop before she was halfway into the saddle.

The storm advanced at an alarming rate, pushing its dust cloud in front of it. Lightning struck nearby with a sharp crack, startling Rabbit, and Devon's excitement began to be tinged with fear. She now regretted making that last delivery. She had never seen a storm move so fast, and she was used to desert storms. Fast as Rabbit was, they weren't going to get home ahead of it. Where to go? Someplace low and sheltered, away from lightning strikes, but not too low, in case of flash flood.

She turned Rabbit off the road, onto a deer trail that slanted steeply downhill between cactuses and junipers and

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brushed past the swordlike spines of century trees. The trail led to a small grotto in the base of a red-gold cliff. The rock walls slanted around and above, protecting. Devon dismounted and stood holding Rabbit's reins, gazing at the black sky. She hoped her husband Jay was safe indoors.

The storm hit. The wind came from all directions, driving red dust in mad circles around Devon's eyes and mouth, battering the cliff. Then a flurry of hailstones threw themselves from the sky, pummeling Devon's head and back though she crouched as far into the grotto as she could. Finally the rain fell, huge heavy drops that stung almost as much as the hailstones. It all lasted perhaps five minutes.

Devon slowly straightened. The storm growled and rumbled as it moved into the lowlands. The Sun came out, making brilliant reflections off the vast white carpet of hailstones strewn across the mountainside. Rabbit sniffed the hailstones and bumped them with his nose, curious, while Devon wrung masses of water out of her red hair. There were tiny bruises all over her head and her clothes were squelching wet, but she felt good. It had all been rather fun. She climbed back onto Rabbit and let him move into an easy trot.

She continued to feel good until she saw what was left of the line of telephone poles, twenty down in a row like giant fallen dominoes with their wires in a tangle between them. She detoured around the mess, shocked. The storm had been much more fierce here, and she was very close to home. She pushed Rabbit back into a headlong run.

Jay met her on the hilltop above their house. She jumped down and hugged him, filled with relief. He said, "Devon, you all right? You had me scared to death."

"I'm fine—sheltered in the grotto. Is everything else OK? The house, the mare?"

"The house is OK," Jay said. "The mare will be. She'll need stitches."

"The glider?" Devon whispered.

"Best see for yourself."

It looked as if a bomb had exploded on the barn. Two trees had fallen across it in a neat geometric pattern, caving in the roof and turning the place to rubble. Jay had already gotten the mare out; she stood tied to the corral fence. Blood from a large superficial wound on her shoulder was sliding down her foreleg and pooling at her feet, but she didn't seem troubled by it; she was nibbling at the fence and eyeing the nearby windmill, which had somehow survived the storm with no damage aside from the aquisition of an irritating squeak. Devon patted the mare and steeled herself to look at the rubble of the barn. Rabbit and the mare had lived in half of it; the other half had housed the glider.

It had taken months to build the glider and she had been using it for the air mail for more than a year; it flew like a dream. Now Devon could see just one wing poking out of the ruins, and the wing did not appear to be attached to anything. Jay grimly walked past her and began to clear away the rubble, bit by bit. Devon couldn't bring herself to join him. She didn't want to see what was left.

"Have you called the vet?" she asked Jay.

"No. The phones are down."

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"I'll go and fetch him then."

She got away from the place as quickly as she could, trembling with reaction. She tried to tell herself that they'd gotten off easy. Jay was fine, Rabbit was fine, the mare would be fine after the vet came. But the *glider*. She'd put so much of herself into the making of the glider, and she expressed so much of herself when she flew it. The road swept past her as the horse moved, but all she could see was the glider's wing sticking up out of the rubble, attached to nothing. It felt like her own arm had been ripped off.

She'd wanted to leave Rabbit at the park-and-ride and take the tram to town, but the electric was down and the trams weren't running. She had to ride all the way in, more slowly than she liked; even in such a small town, a gallop wasn't legal inside the city limits. Abandoned trams were everywhere and people were walking or bicycling through the streets, grumbling about the trams. Devon saw no damage and little evidence of rainfall; the storm seemed to have bypassed the town, taking out only the utilities.

At the vet's office, the waiting room was empty and the receptionist looked unhappy. "The doctor's out," she told Devon. "He went to do a C-section, and with the phones and the electric down I just don't know when he'll be back. It could be quite a while. Shall I put you on the waiting list?"

"Yes," Devon said. "It's my mare. She's going to need stitches. The barn fell in on her in the storm."

"Oh dear," the receptionist said mournfully, writing it down. Then she brightened. "If she just needs stitches maybe a regular doctor could do it."

Devon made a face; she knew the town doctor would do no such thing.

"Oh, I know," the receptionist said, "but there's a new doctor in town. She just came in yesterday on a pack train out of the desert. I heard she was going to set up a vaccination clinic next week."

"Do you think she'd do it?"

"I don't know. But how different can stitching be? She's staying at the Flamingo Motel."

"Thanks," Devon said.

"If she says no, come back and I'll put you on the list."

It did not sound very optimistic, but was probably worth a try; Devon rode off in search of the Flamingo Motel.

Jos van Roos looked out the motel window and threw silent parting curses after the storm. It had taken the storm only seconds to destroy weeks of carefully laid plans. Connard had picked a terrible time for a pleasure ride; the results had been much like the kingdom and the horseshoe nail. A lightning strike, a spooked horse, a man thrown over a cliff, a pilot out of commission, and a plane that wasn't going to make it off the ground. And Connard still wouldn't accept it.

"Just put a cast on," he said stubbornly. He was sitting on one of the beds, his face very white, his right leg encased in a bulky splint. "I can still fly."

"I can't put a cast on," Jos said. "I've told you, it wouldn't work. I'm the doctor, remember? The break is too severe. You have to have surgery or you

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won't ever *walk* again. You're taking the first express to L.A. in the morning, and you're going to have surgery, and you're not going to argue with me any more. I left practice and went into this damned vaccine work to get *away* from patients like you who won't listen to anything I say."

Connard stopped arguing. Jos sighed deeply and sat down in an uncomfortable chair. She picked up the complimentary newspaper and glanced at the headlines: she saw the usual boldfaced, gloomy, tension-filled words. World politics were not going well, and it didn't look as if things were going to blow over. As Jos tossed the paper aside, a knock came at the door.

"Who in the world knows we're here?" Jos said.

"Maid service?" Con suggested.

"We just *got* here."

The knock came again, and Jos got up and answered the door. A girl stood there, dressed in a mud-streaked T-shirt and jeans, her red hair damp and tangled around her shoulders. She looked very young, nineteen or twenty perhaps, an age that made Jos feel particularly old.

"Hello," the girl said. "Excuse me, but are you the doctor?"

"Yes," Jos said warily. "I'm Dr. Jos van Roos." She used her real name deliberately, hoping it would scare the girl off: people tended to shy away from doctors with foreign sounding names. In practice she had been Dr. Jocelyn Rose.

"My name is Devon Swift," the girl said, undeterred. "I wondered if you could come out to my place. To stitch up a wound."

Jos could think of few things that sounded less desirable. "What sort of a wound?" she said.

"It's pretty big, about like so," Devon said, gesturing. She finished the description in a rush: "On my mare."

"Oh no. I'm sorry, but I don't do horses," Jos said, trying to be pleasant. Horses! People were getting crazier all the time. Next it would be pigs, or iguanas.

"Please," Devon said. "The vet's out on a call and they don't know when he'll be back, and it's only stitching, and I can pay."

"I simply don't do horses," Jos said firmly. "They have teeth and hooves and—"

"Wait," Connard said. Jos looked at him, surprised; he was sitting up straight and staring hard at Devon.

"Is that T-shirt for real?" Con asked Devon.

"Yes."

Jos looked quickly to see what Con was talking about. Under the muddy splotches on Devon's shirt she made out the words SWIFT'S PONY EXPRESS AND AIR MAIL. She caught her breath. Fate, she thought. It's meant to be. She was going to have to work on that damnable horse after all.

"You really do air mail?" Con asked.

"Yes, of course."

"Fly a glider? Good at it?"

"Yes," Devon said.

Con gave Jos a sideways glance. He said, "It does sound important, Jos, don't you think? I mean, a wound that big. If I were you I'd go and take care of it."

"Yes," Jos said slowly.

Devon looked confused. "You mean you'll do it?" she said.

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"Yes, Devon," Jos said, "I'm afraid I will."

The electric was still down, which meant they had to ride all the way to Devon's place, high in the hills. Jos had never understood why anyone would want to live off the tram routes, unless, like her friend Mike Decarlo, they had good reason to keep their activities hidden from others. Jos selected a spotted horse from her pack train, an old horse that was quieter than the others. She saddled it and got on with a groan. After two days travelling across the desert she was heartily sick of riding. But there were no proper roads where they'd been, nor where she was going, and the load on the pack train was not exactly legal.

Jos was startled when she saw what was left of Devon's place; Devon had not mentioned the degree of destruction the storm had left behind. The dirt runway was littered with debris, the barn was a mess of splintered rubble, and next to the remains of the barn, a tall young man was piling pieces of glider into a heap beside a smashed launching winch. As they approached, he dropped a piece of wing on to the pile and walked toward them.

"My husband, Jay," Devon said. "Jay, this is Dr.—"

"Van Roos," Jos said.

Devon said, "Jay? That's all that's left?"

"All. It's too far gone to repair."

"So much for air mail," Devon said tonelessly. "Jay, would you put a tarp over it? I just can't stand to look at it."

"Sure, Dev."

Jos found herself unable to stop looking at the destruction; it was a terrible thing, and worse, Jos was glad it had happened. It fit right into her new plans. With Devon out of half her usual work and in need of money to repair the damage from the storm, it would be much easier to hire her. And with the amount of money Mike Decarlo could pay, she could overwhelm the girl. But first Jos would have to do a good job on the horse, and win Devon's trust.

Devon led the mare up, and stood waiting while Jos nervously examined the wound.

"It's OK," Devon said reassuringly. "Her name's Sleepy."

It wasn't as hard as Jos had expected it would be. Fortunately the wound was high on the shoulder, well away from the hooves and the teeth, and the mare stayed true to her name, even when Jos injected the local. It wasn't much different from working on a person, except the skin was thicker and there was a lot more hair to deal with. After bending two needles, Jos got the knack of working with the heavier skin, and she stitched the long wound very neatly.

"It looks great!" Devon said, and immediately asked for the bill. Jos knew she had scored. No one was ever that excited about paying unless they were truly impressed.

"Actually, Devon," she said, "I was wondering if *you'd* be interested in a job. I happen to need someone who can fly a glider."

It was almost dark when Jos got back to town. The electric was back on; she left the spotted horse at the park-and-ride and arranged to have it delivered to the motel tomorrow. The tram was deliciously comfortable after all the

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horseback riding, and it deposited her at her motel within minutes.

"How'd it go?" Con asked.

"I'm still alive," Jos said, and fell heavily across the empty bed.

"I mean, did you *hire* her."

"Yes, I hired her. And I feel like a bastard. She's just a kid. A true innocent. You should have seen the way I took advantage, Con. That storm wiped her out. Smashed her glider and her barn to rubble. So I lied to her, and waved around Mike Decarlo's money, and she never had a chance."

"You make it sound like a crime."

"It is. Remember?"

Con was silent for a moment. Then he said, "Well, I don't think it's all that bad. I mean, look at me. *I* volunteered."

"Yes, but you have some idea of what's going on in the world; you have the advantage of a grandfather named Mike Decarlo. I talked to her for a while. Just to find out what she's like. She *believes* in—in everything: in God, in the government, in the Clean Air Laws, even in worn out doctors giving vaccination clinics. While I was there, I gave Devon and her husband the vaccines. They didn't ask what was in them. They just rolled up their sleeves and let me jab them, because it was required by law." Jos rolled over, stared at the ceiling, and said sadly, "No one ever *asks*."

Devon spent the next week in a happy frenzy of work. She couldn't believe her luck, getting hired for such a high-paying job on the very day of the disaster. Dr. van Roos had paid half down, a staggering sum in itself, and Devon and Jay bought lumber for the barn and hired some men to help with the work. They hadn't yet decided on a plan for the new glider. Devon had loved the old one, and part of her wanted it exactly the same, but another part of her was eager to try something new. Jay was full of ideas for new designs, and he wanted to try using the horses to do a bungey launch off the mountainside, so they wouldn't be dependent on the uncertain electric for the winch. Devon thought it sounded like fun, but though it was fine to hire kids from town to be wing-handlers, she was not so sure she wanted them riding her horses. She was more inclined toward building a new design of glider, and continuing to launch with a winch.

"We'll decide when you get back," Jay said. "How long do you think you'll be?"

Devon got out her maps, and checked distances and contour lines. They'd be going all the way to Aspiring Mountain, high in the White Rock range.

"I'd guess three days to get there," she said, "three back, and oh, say, a week there, since Dr. van Roos has to do the vaccination clinic and she'll want to spend time with her friends there, too. Plan on having me back in two weeks."

"Two weeks. Do you realize how much money that comes to per hour?"

"A lot?"

"It's obscene. I'm jealous. That old guy, what's his name?"

"Mike Decarlo."

"He must be filthy rich. I heard he even has a castle up there on the mountain. Is that for real?"

"Dr. van Roos says there is a castle,

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but it's a very small one. She lived there for a while when she was little, can you imagine? Her father and the old man were best friends."

Devon was intrigued by the idea of the castle. She had never seen a real castle. Would there be a moat, and turrets and battlements? Perhaps not a moat, since it was in the desert. A moat would tend to evaporate.

Jay said, "How many flights do you have to do?"

"I don't know. Who cares?" The more the better, she thought. Dr. van Roos had said that Mike Decarlo, in his old age, had taken a fancy to having a glider ride, and he was rich enough to get what he wanted. The glider was already there, waiting, but the doctor said she didn't know what kind it was. It didn't matter. Devon could fly anything.

Two days passed on the trail, hot and slow, the tedium broken only by the occasional disaster involving either a horse or a load. Jos was exhausted. She watched Devon riding ahead on her eager, spirited horse, filled with energy and having the time of her life, and decided that she was too old to be doing this sort of thing. Even private practice would be better, she thought. Maybe.

Or maybe not. Private practice had been alternately heaven and hell for Jos, with nothing in between. Over the years it had grown to be more of a hell. Lawsuits were commonplace whether there had been malpractice or not; it didn't seem to matter any more. Jos remembered the patient that had driven her over the edge: a four-year-old girl, emaciated, dehydrated, and nearly comatose, was brought in by her mother. Jos had been shocked by the condition of the child and the casual air of the mother, who didn't seem to believe that much of anything was wrong.

"When did you first notice she was sick?" Jos had asked as she examined the child.

The mother had thought for a minute. "I suppose she's not been acting right for about a month. She hasn't eaten in a week. But she only collapsed today."

Jos had worked frantically on the child, setting up IV's and drawing blood for tests, but it was too late; the child died within the hour. The mother accused Jos of murder, and sued. Jos left private practice and went to work for the government, doing vaccination clinics; it was a job she had sworn, years ago, she would never take. She had always been scornful of shot-pushers in boring, unfulfilling jobs. Now she was one of them.

But she was still responsible enough to ask questions. It puzzled her that the vaccines were to be given only to selected communities in the most remote, least populated part of the country; the official explanation was that it was a test of a new brand of a traditional vaccine. When she noticed some unusual reactions to the shots, she went looking for the reason why: even a new brand shouldn't be causing the type of reactions she was seeing. She tried to raise a public investigation but was met with open hostility; she subsided publicly, but snooped privately. She had a friend in research and analysis, and it wasn't long before she found out what she'd really been sticking into people. It was not what it said on the label. It was a

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vaccine for a disease that didn't exist. The organism involved was highly viable: it formed spores that could live indefinitely in the soil, it was species specific for humans, it was highly contagious, and it was deadly.

Jos had gone to see Mike Decarlo, hoping he'd tell her she was wrong, but he had confirmed that these were all excellent characteristics for a biologic weapon.

Jos's horse stumbled and she came out of the past with a rush; she was back on the hot dusty trail, riding the spotted horse. It seemed like she had been doing this forever. And she hadn't even begun to prepare Devon for what lay ahead.

"Devon," she said, "tell me about the pony express and air mail. Is there a lot of business?"

"Oh, yes. As long as you stay with the smaller towns."

"I didn't realize so many people lived off the government mail routes."

"You'd be surprised. And we even do business for people who have the regular mail but want something special. They particularly like the air mail. It's getting more popular all the time."

"I suppose it's kind of romantic," Jos said. "Air mail has such a long history. They used to fly the mail in planes with engines, didn't they? Jets, and gasoline planes?"

"Yes, but they didn't know any better," Devon said. "They didn't have the Clean Air Laws or anything. At flight school they used to show us pictures of all the pollution that used to be in the air. Imagine trying to fly through all that. It's so much better now."

Jos said cautiously, "Mike Decarlo used to fly jets."

Devon looked shocked. "But that's illegal," she said.

"It wasn't then. It was a long, long time ago. Mike Decarlo is almost a hundred years old."

"A *hundred?*"

"Yes."

"I suppose there wasn't anything else to fly back then." Devon was thoughtful. "I wonder what it was like."

"He says it was wonderful."

"Well, it *was* flying," Devon said doubtfully. "I suppose."

Jos slowed her horse and let Devon ride ahead—at least the girl was giving it some thought.

They reached the castle on Aspiring Mountain at sunset the next day. It was as beautiful as Devon had imagined it, with turrets and battlements, but with no moat. The castle had been built long ago, out of native rock: eight stone turrets, each with a flag fluttering on top, circled a five-story octagonal building. The building was draped with solar panels and mirrors, and cacti grew between the rocks on the turret walls.

Beyond the castle were outbuildings and a number of small houses; it was practically a village, though Dr. van Roos had told her that it was really one big family. On a wide plateau below the castle and the village was a hangar, and leading out from the hangar was the longest, widest runway that Devon had ever seen.

Dr. van Roos hurried straight to the castle while Devon took the string of horses to the barn. Two girls greeted her there and energetically began to help with the unpacking. Boxes and bags and crates disappeared from the barn at a

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bewildering rate, and soon Devon was left alone with the tired horses. She began the work of settling them for the night.

Dr. van Roos reappeared with an old man at her side and the same two girls in tow. The old man was riding in a small electric cart.

"Devon, leave that," Dr. van Roos said. "The kids will take care of the horses; I promise they know what they're doing. I want you to meet an old friend of mine: Mike Decarlo. Mike, this is Devon Swift."

The old man held out a hand to Devon, who hesitantly took it; his hand was so frail that she drew back in alarm, afraid that her touch would break bones.

Mike Decarlo said, "Jos tells me you're the pilot."

"Yes," Devon said.

"Well then, let's go have a look at your plane."

The interior of the hangar was dark but Devon could feel something there, something big. When the lights came on she gasped. She could hardly believe that something so big was meant to fly. It was enormous, filling the huge hangar; the fuselage was forty feet at a guess, the wingspan fifty. The wings swept back sharply, unnaturally, against the fuselage, and Devon could see the strange bulges of engines half hidden in the wings. *Engines.*

"What do you think of her, Devon?" Mike Decarlo asked.

Devon could find no words to answer. She couldn't believe what she was seeing. She turned to Dr. van Roos, but the doctor quickly looked away.

"What do you think?" Mike Decarlo said again, his voice touched with worry this time, the look in his eyes pleading for her approval.

Devon whispered, "That's not a glider."

"Oh, but she is." Mike Decarlo slid his stiff, gnarled hand along the leading edge of the wing, and said, "She's the finest glider you're ever likely to see. A swing-wing, Devon. Once she takes off and hits altitude, all you have to do is extend the wings and she's a glider. Wingspan's a hundred feet."

Horrified, entranced, Devon walked from the wing to the sleek nose, where someone had painted a name: *Aspiring.* Beneath the name a roughly lettered scrawl read: (to fly). She reached out a hand to touch it and pulled back just in time.

"What is it?" she said. Her voice didn't sound right; it was muted, strained. "Is it a jet?"

"Yes," Mike Decarlo said. "She's a jet."

"It's *illegal*," Devon said. She stepped away from the plane. "Look, I can't be a part of this. I'm sorry, but I can't. It isn't right."

The old man nodded slowly, and all the eagerness and hope drained from him as he turned away from her and slumped against the seat of his cart. Devon walked quickly out of the hangar, not looking back. After a moment, Dr. van Roos followed her.

"Why didn't you *tell* me?" Devon said. She felt betrayed. The doctor walked a little behind her, more slowly; it was a steep climb up to the castle.

"I didn't tell you because I was afraid you wouldn't come," Dr. van Roos said, her voice steady. "I didn't tell you because Mike Decarlo has been my

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friend forever and this means more to him than you can know. I thought that as a pilot, maybe you'd understand how important it is for him to have one last flight."

"But he can! He can do it properly, legally. He's rich enough; he can send for a proper glider and have it delivered inside a week."

"He wants his flight to be in a jet," the doctor said. "The same way he used to fly. He flew jets years ago, back in the days when they were legal, and that's the kind of flying that he loves, the kind of flying he's been denied for half his life. He's got very little fuel, which is the only reason he built the plane to turn into a glider."

"Then he doesn't need me. He can fly it himself."

"He can't. Didn't you see his hands? He can hardly use them. Advanced arthritis, tendon damage—there isn't any way he can work the controls."

"But—" Devon found that she could not help but feel compassion for the old pilot, but there had to be another way. "What about the other pilot you had? Why can't he just wait for *him?*"

"Because it may be too late by then," the doctor said. "Mike Decarlo has cancer, Devon. He's dying."

Devon, in turmoil, could find no answer to that.

Dr. van Roos showed her to a turret room high in the castle, a small room equipped with a bunk bed, a few shelves, and a large window overlooking the plateau. Devon was too tired and too edgy to sleep. She lay on the top bunk, looking out the window. All of the outbuildings were dark and silent except for the hangar, which still gleamed with lights and activity. She looked down on the hangar and could not keep the image of the jet out of her mind. It called to her, drew her; she found herself longing to fly it, and the longing filled her with terrible guilt.

She jumped out of bed. She had to stop this pattern of thought; she had to do something. She found a flashlight, let herself out of the castle, and walked down to the barn. Rabbit was asleep, curled up in a corner of his stall, but he woke when she came in, and lurched to his feet. She put on his bridle, swung on bareback, and rode him down to the plateau.

The Moon was full and high. Devon switched off the flashlight and rode silently past the hangar. The giant runway loomed ahead of her, bathed in moonlight; a small hand-painted sign caught her attention and she switched the flashlight back on: it read ASPIRING INTERNATIONAL AIRPORT. She smiled in spite of herself. International, indeed.

The runway was new, with no cracks, no overgrowth of weeds. Rabbit's hooves tapped lightly on the asphalt as he walked down the runway to the very end, where it fell over the edge of the cliff into blackness. Devon looked up, into the stars and sky, and longed to fling herself into them. She had a brief, crazy notion of sending Rabbit down the runway at a dead run and riding him straight off the cliff; if they built enough momentum, would they fly?

Maybe it wasn't so much to ask. A dying old man's last request; a dying pilot's last flight. A single jet takeoff would do little harm to the ecosystem or the atmosphere. In this remote place no one would hear the noise of the take-

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off, and no one would ever know that the jet had flown.

There aren't any good answers, Devon thought in frustration. Nothing was right. Either she broke the law or she broke the heart of a dying old man. What was she supposed to do? She couldn't make this decision; it was too big for her. But what about Dr. van Roos? She was a *doctor*, she even worked for the government, and she wanted Devon to fly the plane.

Devon turned Rabbit around and rode back to the hangar.

Jos was sitting up in bed, staring at the walls, when Mike Decarlo knocked lightly on the door and rolled his cart into her room. He looked tired, but he was smiling.

"It worked," he said. "She came to me and said she'd changed her mind. She'll fly."

"Thank God," Jos whispered.

"You're sure you don't want to tell her what's really going on?"

"I'm sure."

"So what am I supposed to tell her when we're up there, and it's time to launch the missile?"

Jos hadn't thought of that. She said, "Isn't there some way you could keep her from noticing?"

Mike frowned, thoughtful. "I can have the panel wired so the launch instructions only appear on my board; that's easy enough. But she'll be able to *feel* the launch, and hear it. I can't hide that."

"Couldn't you make up something to tell her? Some malfunction in an engine, or turbulence in the air, or something like that? Maybe she wouldn't know the difference."

"Hm. Maybe. I suppose it's worth a try."

"I wish we didn't have to involve Devon at all," Jos said.

"Not much choice."

"I know. It's just that she's so *innocent*. So patriotic, so law abiding. I feel like I want to protect her from what's really going on in the world."

"If that's what you want," Mike said.

"You don't agree."

He shrugged. "My grandkids are a long way from innocent, patriotic, or law abiding, and I think they turned out pretty damn well."

Jos thought for a moment and said, "I guess I don't want her to turn into someone old and tired and cynical. There's a vivacity about her, a love of life, of what she's doing. When she talks about flying—well, I used to feel that way about medicine. Once. I don't want her to lose that feeling."

Mike nodded, understanding, and said, "I'll have them rewire the panels *first thing in the morning*."

He left, and Jos got ready for bed, but sleep refused to come. She put on a robe, went down the spiral staircase to the living room, and settled herself on a couch. She'd been sitting in this very spot months ago, when she'd first brought the news to Mike.

"So much for the ban on nuclear weapons solving the problems between the nations," he'd said. "It's back to the basics. The simple germ, pure and natural."

"I don't understand what they're doing." Jos had made a detailed map,

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plotting the areas where vaccination clinics were being held; the area involved was about half the state, and in that area, less than half the population was scheduled to be vaccinated. Jos had unfolded the map on the table and puzzled over it; Mike had leaned over to look.

"Interesting," he'd said. "It looks like a test."

"What do you mean?"

"Why else would they vaccinate only part of the population? And why in such a small area? If they were going to use this thing on an enemy nation, they'd want to protect everyone in the country."

"You mean the government would use a deadly weapon on *us*, just to test it? That's crazy."

"Of course it's crazy, but why should that stop them? They've done it before. Once they dumped flu bugs into subway stations full of people, just to see how the stuff would distribute; some old folks died of that flu. And this area you've mapped is the same place where they used to do open air tests of nerve gas. You know as well as I do that we're right in the middle of a traditional dumping ground. You'll find everything from nuclear waste to leftover mustard gas buried around here. People around here have always been considered expendable."

Jos had whispered, "Then this *is* a test."

"I don't see what else it could be. Look at it from their point of view. They can test how well their bug kills, and at the same time, they can test how well the vaccine works."

"We can't let that happen. We have to vaccinate everyone."

"How? There isn't any way you can cover the area yourself, and if you mobilize a group to do it, you'll be found out, and stopped."

But Mike had not given up the problem; he'd rolled his cart silently around the room for almost an hour, stopping occasionally to stare out a window or gaze up at the skylight in the ceiling. Suddenly he'd turned to her and asked if her friend in research and analysis could make the vaccine as an aerosol.

"I don't see why not," she'd said.

"Could she make a lot of it? A lot more than you've got now?"

Jos had shrugged. "I expect she could make however much you want. But what good would it do?"

"Well, you can't get to everyone to stick them with a needle, so you've got to get the stuff airborne."

She'd laughed. "What, drop it from a glider? Mike, I think they'd notice."

"No. Launch it from my airplane."

Mike had gotten more and more excited as he'd outlined his plan. Fuel was a problem, but Mike's antique jet already had the capability of adjusting its wingspan to take advantage of different windspeeds; Mike thought he could modify it to adjust all the way into a glider. He wouldn't be able to fly it, but Connard, his grandson, was in flight school and was soon to graduate; Mike said that any glider pilot, with a bit of coaching, could handle a jet takeoff.

Slowly, the foundations of the plan had fallen into place.

"I hope we're doing the right thing," Jos had said. "I think they call this treason."

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"It depends on who's defining the word," Mike had replied. "We're doing the right thing."

The takeoff was louder and more frightening than anything Devon had ever imagined; if Mike Decarlo hadn't drilled her on takeoff procedure for days, she would never have been able to do it. She sat terrified in her seat as Mike Decarlo calmly talked her through the procedures that brought the engines to a crescendo and blasted the plane off the runway under its own vast power. Even when they were in the air the noise was tremendous; the engines roared and shuddered, and the plane plowed through the winds heedlessly, making no use of them at all. They reached altitude with startling speed: it was higher than Devon had ever been, higher than any plane had any right to go.

"Just a drop of fuel left," Mike Decarlo said cheerfully. "Ready, Devon?"

"I guess so," she whispered.

At his signal she worked the controls that extended the wings, and began to cut back the engines; as the wings moved away from the fuselage and spread to catch the wind, the horrible engine noise faded, and finally died away. It was blessedly silent. With wings at full extension, Devon felt much better. Huge as the thing was, it *was* a glider, and handled like one; she could fly it. But they were too high. No glider should ever fly so high. It wasn't right, it wasn't natural. At this height even the winds didn't behave the way they should.

"Can you fly nice and straight for me for a minute, Devon?" Mike Decarlo asked.

"OK," she said. He was busy at his control panel, looking at something she couldn't see. What could he be so busy with, since she was doing the flying? He was humming cheerfully. Good, she thought, he'd *better* be enjoying this, considering what she was going through to give him this last flight.

Mike Decarlo reached out and clumsily touched a button on his panel. The plane lurched, as if something had struck it in midair, and Devon cried out. She lost control for an instant; then reflexes took over and though her mind was in shock, her hands guided the plane back into the wind.

"Just some turbulence, Devon, that's all," Mike Decarlo said, but his voice sounded odd, and he looked at her sideways when he spoke.

Devon was sure it had *not* been turbulence, and she had seen Mike Decarlo's slow and clumsy move toward his controls. Something strange was going on. Mike Decarlo was looking at her now, looking at her with that hopeful, pleading expression, as if he *wanted* her to ask, *wanted* her to question what he'd said. She opened her mouth to do so, then closed it. *She didn't want to know.* If she knew she'd never be able to forget it, never be able to put it out of her mind. And now, more than anything, she wanted to pretend she'd never made this flight. It was wrong, all wrong; she'd made a terrible mistake and she wanted only to get to the ground and put it behind her.

"Mr. Decarlo," she said, "can we go down now?"

"Yes." He looked sad, disappointed, but all he said was, "I've gotten all that I wanted. Go ahead and take her down."

* * *

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Jos watched the fading contrail long after the plane had vanished from sight. They must have reached altitude by now, 40,000 feet, and even now they'd be turning the jet into a glider. Any time now, Mike would launch the missile.

Somehow Jos had not been surprised to learn that Mike possessed a nuclear warhead. He hadn't wanted his airplane to be defenseless, and years ago, when he'd bought *Aspiring* and delivered her to his mountain retreat, he'd used his money and influence to have her secretly supplied with a missile. That was simply Mike; it was the way he did things. He'd dismantled it long ago, removing the nuclear works, he'd never meant to use it, just as he'd never meant to fly the plane.

Jos glanced at her watch. It was past time; Mike had launched the missile. She smiled, watching in her mind's eye as the missile swept away from the plane and headed for the target area. The payload was now vaccine, in aerosol; the trajectory had been calculated to provide maximum concentration to the test area Jos had mapped. Now, when the government tested their weapon, they'd find it harmless; Jos hoped they would then give up the whole thing, in disgust.

Later, as she sat inside the castle with Mike Decarlo, Jos felt as if a great burden had been lifted. It was over at last. Mike had even succeeded in keeping Devon from noticing the launch. She'd accepted his explanation.

"But I don't know why," Mike said slowly. "I'm sure she didn't believe me. She knew something was up. She almost questioned me, Jos. *Almost*. I'd made up my mind that if she asked I was going to tell her, and damn the consequences. I *wanted* her to ask. But she didn't."

Jos felt part of the burden slip back. "No one ever asks," she whispered, and wondered if she'd done the right thing for Devon.

"She didn't like the flight either," Mike said. "Too fast. Too high. Too new, and different."

Jos sighed. "Well, at least she flew it. In the end that's all that matters."

"Is it?" Mike said. "I wonder."

The pack train set off down the mountain on a bright early morning, and Devon was glad to be leaving the castle behind. She'd left the mystery and the mistakes behind as well, and had rubbed the slate clean; as far as she was concerned, the flight had never happened.

It was good to be back on Rabbit, riding at a fast clipping walk along a desert trail with the hot sun beating down on her head and the pack train following obediently behind her. She patted Rabbit's hot neck and smoothed his mane. She couldn't wait to get home. She missed Jay, and she was eager to start work on the new glider. She'd already decided on the plan.

It was going to be exactly like the old one. ■

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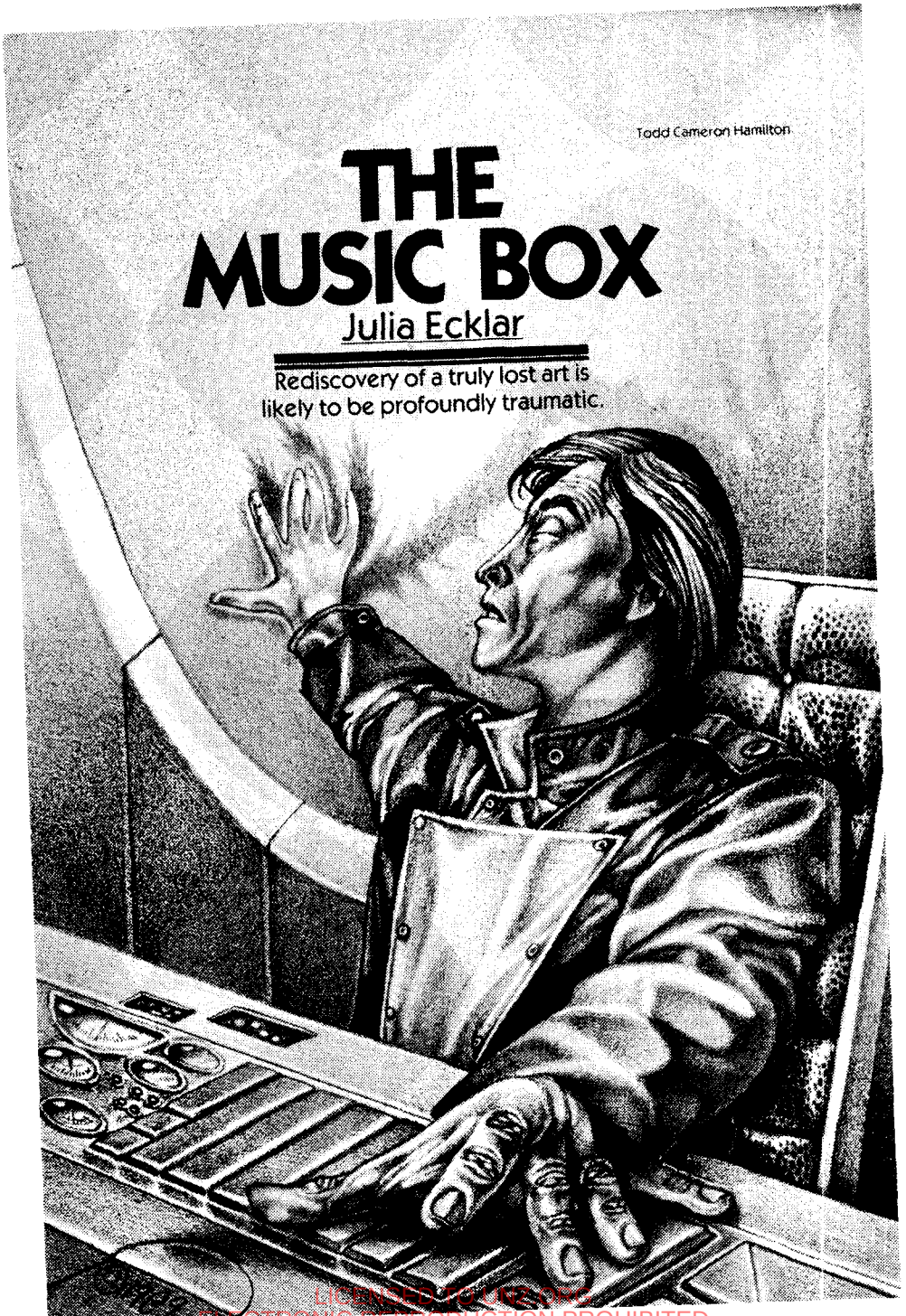

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The Newborns draw me toward consciousness on life-lines of gossamer music. Although technically unsound, the song they weave is almost pleasing. My trained ears recognize the ordered structure of their music—an ability indicating the higher logic necessary to command language, use tools, and be accepted as sentient creatures. Begun as robots built of plastic and wire, papers from Earth's government make the Newborns people now. Can this concept work in reverse, I wonder?

I open my eyes.

In four hundred years, my cabin has never changed. The bureau, its drawers containing seven identical black-and-white singlets, is part of the bulkhead at the foot of my bunk; the shower nestles in the corner between bureau and door—my bathroom. I bathe, shave, and urinate in the shower stall; defecation is done into little plastic bags which Waiter then carries away. There is no table here, not even a chair. There's really no need; I use the room rarely for anything but stasis sleep.

"Good morning, maestro. Captain Swedien requests your presence, ASAP."

The voice belongs to Waiter, one of the ship's Newborn robots. He has been at every audition for the past four hundred years, waking me and caring for me until the time to sleep returns. The music of his servos and finely jointed limbs is part of the first music I hear when sleep releases me to the world.

"Breakfast is ready," he says, even though he has no mouth. His molded plastic face and wise, electric eyes stare at me as I turn a head which feels unconnected to my body. "Whenever you're ready." Seven softly singing Newborns array the room behind him.

I try to sit up—too soon. Waiter keeps me from falling when I swing my legs over the edge of the bunk. It's like this every time, but Waiter still reassures me, "You're only just awake, maestro. You'll feel better in a minute," as if I've never done this before.

"Where are we?"

"Omega Lyrae."

I stand and stagger toward the shower. Ephemeral snatches of a melody taunt me, scattering from cognizance when I try to listen. Perhaps it is only the Newborns's shallow music. Or perhaps I remember some yesterday. "I take it they've found an orpheus?"

I think he nods. I can't recall if Waiter's able to nod or not, but I sense affirmation in his silence.

"Most of the crew has been awake for better than a week," he explains as I clumsily turn on the water. The sudden hot spray hurts, a welcomed release from numbness. "They wanted to wait before waking you."

An unidentified discomfort pushes at me from where it struggles in stasis sleep far inside. I come out planning to let the air dry me, but Cook is already there with a towel. He rubs away the water while I search for my clothes. "Is something wrong with the orpheus?" A singlet is laid out on my bed, just like always. "What have they done without me?" Because auditioning is *my* job—*my* privilege as a musical sport and a maestro. Auditioning musically inclined aliens is the only rationale for my existence.

Waiter watches me dress. "Nanny

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found the orpheus on Omega Lyrae IV," he explains. "She heard it singing from four thousand meters' distance, and sent for a retrieval team. The team found it under a rock slide, wounded." He pauses while I key open the door and pass into the long, empty corridor. Only Waiter follows.

"It killed Nanny and four others before the transport docked with the ship," he continues when we reach the elevator. A retrieval team is manned entirely by Newborns; the captain and the Human crew remain sleeping until after an orpheus is aboard. Nanny, in fact, was one of the first androids to petition for sentient status in Earth's courts. "Miner dug it free; it tore off Miner's arm." Miner is Waiter's special friend.

"I'm sorry," I say, because it is habit, and it is expected of me.

No expression moves across Waiter's plastic face. His blue eyes stare without blinking at the closed elevator doors. I wonder what Newborns think about.

"What's happening with the orpheus now?"

"Captain Swedien and the doctor—" *He never calls Dr. Nereid by name.* "—have it locked in the Music Box. They're trying to sedate it. The doctor wants to run tests."

"What do they need to know?" And how can they expect me to audition a violent, dangerous orpheus if it tears the Music Box to shreds?

If Waiter were Human, he would probably shrug. Instead he studies the air in front of him until the elevator opens on a corridor just like the one we left behind. "Regs," he says simply.

I cannot comment. UN Regs won't let a talent scout bring sentient beings into Earth's work force, and Captain Swedien pays a great deal of attention to regs.

Waiter leaves me at the doorway to the Music Box. He touches my hand fleetingly with one rubberized gripper before backing away. "Break a leg," he wishes in his toneless, filtered voice. He doesn't know what the phrase means any more than I do.

Inside the Music Box, Swedien and Nereid stand near the view-port, trying not to touch the keys or stops of the Music Box's controls; when the door whisks shut, they swing about as if caught doing something they oughtn't. I pretend not to notice their chagrin.

"Maestro!" Swedien tries for an expression of pleased relief, and fails. "I expected the Newborns to bring you sooner. I was worried!"

"I imagine you were." I am, after all, an expensive commodity; it would take Swedien years to afford another maestro. "Without your only sport, you might never find out why this orpheus is dismembering your mechanical crew." Walking past her, I try the door to the Box's inner chamber. *It is locked.*

"It hasn't restricted itself to the mechanical crew," she explains apologetically. She crosses her arms over her boy-flat chest and leans back against one of my instruments. "Haas is down in sickbay. They say he'll probably die."

I wonder what Haas was stupid enough to do, but ask the more important question. "What did the orpheus do to him?"

Nereid makes a disgusting noise through his nose. Horror glitters briefly in Swedien's eyes. "You sports are certainly a morbid lot," the doctor com-

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ments baldly. "Do you want to move things into sickbay so you can watch him die?" I begin to remember why Waiter doesn't like him.

"How this orpheus functions and defends itself could matter to the quality of its music."

"Unless it's sentient," the doctor interjects, "it doesn't *have* motives, only instincts."

I don't let his bad manners dissuade me. "You're worried that it's sentient, or you'd have awakened me a week ago. That being the case, I won't overlook anything—even Haas's privacy."

"Chemical burns, mostly." Swedien stumbles all over herself to accommodate me where the doctor won't. "Inhaled and absorbed toxins, as well. The orpheus sweats lethal chemicals, and pisses something that stinks worse than a fabrication plant's castoff bins. Nobody but a Newborn stands a chance of staying with it for more than a few minutes, and the Newborns refuse to cooperate after the fiasco with the retrieval team." She turns her head to stare into the inner chamber, and dark hair slides across the red epaulets of her grey-uniformed shoulders. "I'm beginning to think this isn't worth it. That we should just leave it here."

If her opinion were all the UN needed, sports wouldn't be trained, and *I* wouldn't be on board. I move away from her, past the surly doctor, and look at the orpheus waiting inside.

It's an amazingly ugly thing. Long, wrongly-jointed limbs extend from a glistening, green-black body. I hesitate to call it an insect, but there is something extremely bug-like in the segmented lines of its body, in its chitinous face and faceted eyes. Despite an appearance of hardness, however, sensors say its skin is actually more like worked and shrunken leather. I recognize at least three pairs of optical sensors.

The orpheus worries its foremost appendages in a mouth too tiny to take seriously, crouching like an exoskeletal squirrel in one of the Music Box's corners. There are pools and smears of excrement littered throughout the Box. The orpheus hasn't touched any of the instruments locked in the chamber with it; the computer doesn't record a single attempt at communication or creation.

"What makes you think it's intelligent?" I ask Nereid, not looking away from the orpheus.

Nereid makes another noise, a different one. He has a never-ending supply. "*I* don't," he is quick to reply. "*She* does."

"Captain?"

Her only response is to switch on the Music Box's internal monitoring system. Our portion of the Box is smothered in music—music utterly alien even to my learned ears. Swedien chokes on her breath as if struck to the heart; I look over to see her straining poignantly toward the orpheus trapped in the next room. There are tears on her smooth, ageless face. This doesn't help me to understand why she thinks the creature is intelligent.

I reach over and turn off the connection. Silence swirls around us like wind through an open door. Swedien is still crying; I find I prefer the Music Box without the overwhelming presence of this orpheus' song.

Nereid appears suddenly at my shoulder. He's dressed in the same, soulless

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grey as the rest of the crew, the same color as his soulless eyes. Only I wear the black jumpsuit of a maestro, the triangular panel of white down my front making me stand out from the rest of them like a candle in a cave. A lily in a field of mud.

"How does it make that noise?" Nereid asks bluntly.

"It appears to make music the same way a pipe organ does." Why am I speaking to him? What justification does he require? But the subject interests me, so I go on. "It sounds as though it forces air from its thorax up through hollow sections of its face. Vocal overtones make the song more complex."

Nereid does not move or look away from the ugly orpheus. "So air and its face are all it really uses?" The concept seems to please him.

"That's what I said. Why do you care?"

"I was curious." Nereid's voice is as grey and indistinct as his eyes. "That's all."

I don't care enough about his interests to disbelieve him.

"I'll let you know when I have something," I inform the captain and the doctor.

My announcement is the signal that they may leave me. Swedien looks briefly as if she may protest, but she doesn't, and I am soon alone.

The orpheus' song does not change.

No one but myself and a handful of Newborns enter the Music Box, outer or inner, once an orpheus is there. No one knows how to use the Box but me, and no one can be trusted to care for my expensive person but the Newborns. It is a strange and satisfactory symbiosis.

The small room stinks of my sweat by late in the day, and rows and rows of computer eyes show nothing but mathematical equations representing what I hear. The orpheus stares at me through the thick window, never once interrupting its lyric wail.

I stare back at it until late night. I can do everything except attach myself to the orpheus' thought stream—everything that ought to reveal if instinct or intellect guides this alien song. I listen with my eyes wide open, listen with my eyes tight closed, eat what Waiter brings me, look at the computer's interpretation of the song without listening to anything at all. The music shatters across the Music Box's monitors in ripples of blue, gold, red, green, more colors than I have names for as I analyze every quarter-tone and nuance of the song. A complex song. A precise song. A pointless, meaningless, repetitive song.

Something I cannot reach infuses each chord. I hear the song's every frequency, play back every note, and the orpheus continues to sing as if obsessed. Perhaps this is not music after all, but merely innocent, ignorant noise.

The Newborns herd me off to sleep when I grow too exhausted to choose actions for myself. They sing me into dreams where their voices are themes in the orpheus' song—where I swim in a nightmare wash of music and color, afraid the song will smother me in the night, and I will die.

"What have you done to it?"

Nereid draws his nose away from the Music Box's observation glass and af-

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fords me a look that says I'm nothing more than an annoyance to him. Over the speakers and equalizers, I hear the chaotic remnants of the orpheus' magnificent song.

"What did you do to it?" I demand again, stepping through the covey of Newborns accompanying me. They scurry after my footsteps in a furious electronic effort to keep pace. "Everything sounds all wrong! Have you touched my equipment?"

"Of course not!" Nereid insists with indignation. "I couldn't care less about this garbage! I have *real* work to do." He angles a look toward the inner chamber.

The ruined music resonates through my skull, making me vaguely sick as I absorb the readings given me by my instruments. The flaw here is more than just an interrupted note pattern, more than a disruption in the steady, meaningless skirling of one maddened orpheus. What is missing isn't part of the frequencies, but part of something whose identity still lingers at the edges of my reason. There is a tight, aching pressure in my heart; I suddenly want to strike Nereid with all my power, but control the impulse in favor of more productive activity. Abandoning my instruments, I turn my gaze toward the Music Box's core.

The orpheus no longer cowers in the room's farthest corner; limbs akimbo beneath its sprawling bulk, it occupies the centermost position in the cell. Sparkling ichor that is most likely blood decorates the floor all about it, and two of its uppermost appendages are missing from its quivering body. I know without asking that Nereid has taken those appendages away.

"Never touch it again." The pressure in my chest does not diminish—I hope I'm not ill, because I don't want Nereid to touch *me*, either. "Until I have completed my studies, you are to have no access to this orpheus at all. Do you understand?"

"Swedien knew I was here," Nereid begins, but I silence him.

"Don't touch it, Doctor!"

Waiter and the others glide anxiously to my side. Nereid glowers at them with a disdain colored faintly by uncertainty. "I have what I need."

The knot in my chest doesn't dissipate, even long after Nereid and his self-important attitude are gone.

And, late into the night, the discomfort inside me doesn't change.

I try not to think about the orpheus as I hover on the brink of natural sleep, but I can't banish the music from my mind. It spirals all throughout the darkness of my cabin, spangling off the plasticine surfaces of my dormant Newborns, ringing through the plexiglass enclosure of my shower. I want to understand the song—to find some reason *why* the orpheus sings beyond my ability to analyze. I want to encapsulate and exorcise the alien roiling this damnable orpheus has sung to life at the pit of my being. The music drives all the wants into senseless babbling, leaving me shivering in the darkness of my cabin while deathlike rending creeps across my frame.

"Getan?"

That's my name. How long has it been since I've heard anyone call me

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by my name? I find it suddenly important to acknowledge Waiter's summons, but the awfulness inside me thrusts a thickness in my throat, and I can't speak.

"Getan? Are you all right?" Waiter's eyes cast ice-light across my torso as he approaches my bedside.

I swallow back the sour thickness. "I'm dying."

Waiter doesn't stir. "How so?"

"I don't know!" I gasp against the pain. "But it's true. In here . . ." I touch my middle. ". . . and here . . ." I touch my heart. ". . . and here!" Both hands move to cover my face without my willing it. The orpheus' song hurts my eyes, and fills my head with fear. "There's something inside me that wants to get out, and it's tearing me apart! That orpheus' song is all I can think of—all I can hear! That song, and what Nereid has done to it!"

". . . the song . . ." If Waiter had breath, it would be a sigh. One gripper creeps up to touch my face. "These are *feelings*, Getan Piers," Waiter informs me gently. "Feelings of sorrow for the orpheus—sorrow from the song. It's the *music* that did this to you."

Music. Betrayed by my pure, mathematical music. How does he know?

"Do you understand what powers music, maestro?" Waiter asks me when I don't pull my hands from my eyes. "Do you know why *you* are a maestro?"

"Because I'm a sport." There is wetness on my face, beneath my hands. Waiter is wrong—I *am* dying, even as we discuss it. "I can make and understand music when no one else can. I can see music in all its perfect, metronomic cleanliness." All the Nereids in the universe can never ruin or change that; it is *talent*, true talent such as people aren't born with anymore. That makes me superior to them all. I *will not* let an orpheus disturb the surface of those calm waters. Not even this one. Not even now.

"Wasn't there ever a time," Waiter insists, "when music was something more to you than this? When it was release for your soul, and your heart, and not just what the government selected you to do?" His words are meaningless, noise without thought. Like the orpheus' song. "Don't you remember when talent was the maestro's blood flowing through the music, and not just the maestro's mathematical understanding of the intervals and chords?"

I try to remember—but my past is littered with stasis dreams and brief awakenings; it is a hard and treacherous path to retrace. "I . . . don't remember . . ."

Waiter grips my arm until I pull my hands down and look at him. He is flanked by the other Newborns, their eyes pastel stars against the blackness of my quarters. "You've been raised to seek out musicians who meet some ancient standards of quality—you've been trained to bring home what Humanity doesn't breed for itself anymore. But hasn't your soul *ever* rebelled to the despair and loathing in Mozart's *Requiem*? Haven't you ever created a world to the strains of Handel's *Water Music*?" His voice achieves the intensity of a star drive's moan, aching in counterpoint to the ever-present music in my mind.

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"I . . . I *never* . . . !" I whisper helplessly.

"Getan, did you *never* feel music's thundering love? Or have you always only felt what someone else said was real?"

The pressure inside me explodes in a shower of hurt and hideous joy. Wet spills across my cheeks anew, and I can no longer breathe in an easy, natural rhythm. "I don't remember!" I cry in apology, for Waiter understands what is happening so much more clearly than I. "All I can ever remember—is—is *cleanness*—is *music!*"

I remember nothing such as the orpheus spews into its singings every day. Is this the secret of the orpheus' music—these ephemeral "feelings" that Waiter insists I understand? What a wild, raving, ludicrously abstract concept! The prospect of waiting until morning to vent this lightning bright cognizance is preposterous; I stumble to my feet among the delicate, gentle Newborns that have always replaced Humans in my life, and flee for the Music Box without thinking to put on my clothes.

My heart bursts with passion at the sound of the first elegant chords. Oh, the agony of understanding! Was music always so thick with life and beauty beneath the notes and tempos of my brilliant belief? Waiter and the Newborns surround me as I fall upon the Music Box's mechanism, holding me upright when the power of these new "feelings" would sweep me away.

The orpheus responds, turns its hideous face toward the window. . . .

And the Music Box comes alive with voices.

The orpheus sings to me, and I listen, and I *know,* and I answer as illogically and non-melodically as my withered, used-up soul can manage. Still, it is the most perfect of symphonies—alien to bereaved alien in a conversation we both understand beyond either race's ability for words. I play out frantic, inspired music until my hands bleed across the instruments, until my heart leads me to throw open the ship's intercom and share my newfound humanity with everyone on board. The Newborns's eyes are bright as they add their electronic voices to the song.

I am the maestro; I conduct a magnificent symphony of tears and desperation. I cannot still the song, even when Nereid's voice roars like dragon's breath outside the Music Box's doors. "Stop it, Piers! Stop the noise-making *now,* or I'll go to the captain about this!"

I'm only a pawn of the music; the song stops when it is finished, and not a note before.

Nereid makes the crew burn the lock, dragging light like a high, broken descant through the heart of the song. Even when rough hands capture mine so that the doctor's sedative might smother me, the music protects me with wonder beyond anything I ever imagined. "It's free!" I rave to Nereid's angry visage. "We've set the music free—you can never capture it again!"

"Wheat upon stone," the doctor tells me. "Your music falls upon deaf ears, maestro—dead where it lies."

The sting of his injection can't quiet my exaltations; although Nereid thinks me defeated, music fills my dreams with life throughout the fever of a drug-induced night.

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* * *

Awareness returns smelling like sweaty synthetics and blood. My hands are bandaged, and my bed clothes tangled from dream-riddled sleep. Only the Newborns are with me. Waiter says nothing as I throw on my singlet and rush to the Music Box, on fire with a frightening purpose: the orpheus is sentient! I sang with it last night, and I know what sentience means now more than I ever have before!

The Music Box, when I reach it, is closed to me. No amount of pounding or shouting rewards me with entrance; they intend to sleep me again. They think the audition is over. Swedien finally sends Humans to stop my violent efforts because my Newborns refuse to intervene.

"Where is it?" I demand, my voice rough with fear and the strain of shouting at the Box. "What have you done with my orpheus?"

Swedien's face on the ship's intercom is wet and red. I realize now that, somehow, she understood the music all along. "In the storage hold . . . with Nereid."

Nereid, in his graciousness, shows me the orpheus one final time. I am accompanied by my Newborns, and no one stops me from approaching the packing area because the Humans are all afraid of the crazy maestro. Nereid makes his own foul music, consisting of ugly faces and disgusting sounds, as they load the skinned orpheus into a sleeper tank much like my own. It is somehow more hideous without its hide, as though every ugly secret of its existence has been revealed for defiling eyes.

"It's fabulous!" the doctor crows. "The outer skin isn't a skin at all—it's another being! It rode the orpheus as a *tool*—transmitted complex commands through the creature's central nervous system! It even tried to communicate with us when we moved it!"

"This orpheus is sentient," I murmur numbly. "I'm finished with the audition, and pronounce it sentient. It—it displays a technical sense that suggests an ability to command structured language." This is a lie—no computer could recognize what this orpheus has shown me. But I no longer care about the structure of Earth's laws—it's the *music* I'm desperate to save. "You can't transport it to Earth."

Nereid dismisses my pain with a negligent wave. "You have no power outside the auditions, maestro. Unless you can *prove* this thing is sentient, we can transport it anywhere we choose. Those appendages I took proved the outer parasite possessed the ability to command a rudimentary language, as well as use a tool. Those two qualifications are all the UN specifies. The parasite, then, stays on Omega Lyrae. All *you* know is that the orpheus can sing." He wrinkles his nose, squinting disapprovingly at the Human workers who lower the translucent lid into place. "You said yourself it never even figured out how to use the idiot machines in the Music Box. Sentience by the UN's standards is all we care about here. *You* know that, and *I* know that."

And the UN is made up of Humans, not even of sports like me. "It *feels*," I could tell them. "I sang with it! I know!" My whole life culminates in this mission, reminding me how piti-

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fully incapable the UN is of understanding.

"It's a fine catch!" Nereid declares, a huge, horrid smile splitting his ugly face. "It'll bring this ship a fine commission!"

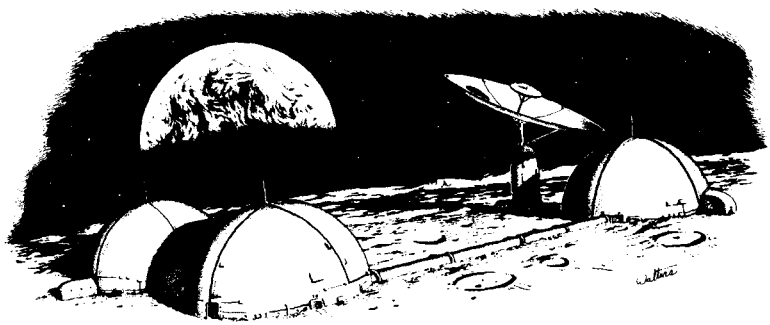
I want to argue with Nereid, to savage his soul and make him understand. But reality is spinning out of control beneath me. Before I can think to protest, I feel the cold, soothing gush through my veins that signals the beginning of another long sleep. I don't even remember being taken to my cabin.

"I'll never wake up again!" I promise Waiter. He is patient at my side, as always. I think I love him, but don't know how to be sure. "I don't want to live among dead people! I don't want to die among a race that never *hears* the music it steals from other worlds!"

"You'll awaken," Waiter croons, stroking my cheek with his machine-cold hand. "Over and over again. You are a sport, Getan Piers—orpheus as much as any of the creatures you audition. Once you've recognized it, you must always acknowledge the descents into hell."

My soul finally rends asunder, leaving me to die on the inner grounds of knowledge and despair. As Waiter's eyes mushroom into the brightness of mindless sleep, I listen to the Newborns sing me into oblivion, wondering what madness will greet me upon awakening.

Wondering if the symphony the Newborns create was always this lovely, or if I'm only just hearing it for the first time. ■



●Mere unassisted merit advances slowly, if—what is not very common—it advances at all.

Samuel Johnson
submitted by John Hradsky

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The Alternate View

THE DEMISE OF THE TOONERVILLE TROLLEY

G. Harry Stine

I am a railroad buff and a model railroader (HO gauge). When I was growing up in the 1930s, trains were really the only way to get anywhere on a reliable schedule, the airlines of the time being notorious for staying on the ground when the weather got bad. I have a lot of fond memories of train travel in the high days of the ascendancy of rail. During summers while I was in college, I ran the little cog railroad (rack railway) between the Broadmoor Hotel and the Cheyenne Mountain Zoo in Colorado Springs. When I lived in Connecticut, I loved to ride the trains into Grand Central Station. . . . but, dear friends, that was a quarter of a century ago, and things have certainly changed there! My last train ride was on the D&RGS Silverton narrow gauge from Durango to Silverton.

I preface this column with these observations lest I be accused of being an insensitive person because I'm going to discuss the twilight and demise of the railway train.

Passenger rail transport has proved over the last 150 years to be a real money-loser. George Stevenson really didn't want to haul people on the Stockton & Darlington in England. He'd built the railway and the "Rocket" steam locomotive to haul freight; the passengers climbed aboard the coal wagons and rode anyway because it was better than a stagecoach or a horse. And there were no real roads to speak of, certainly not as we know them today.

Railways seem to work only where the population density will support them and where routings are fairly settled ahead of time so that you can count on a large number of people coming and going between definite places. Railways seem to work only where the government is either heavily subsidizing them or operating them as owners. Sure as hell no one, even Commodore Vanderbilt, ever made any money *operating* a railway; money was made building and selling railroads as well as manipulating the stock.

The first transcontinental railroad was built with government guaranteed loans which, because the Union Pacific/Central Pacific was the only game in town for many years, were paid off by 1895. Jim Hill's Great Northern Railroad was privately built, but that didn't keep it from going bankrupt or defaulting on its notes, either, just like all the rest of the railroads.

Railways never really made a profit hauling passengers. It got worse and worse until, shortly after World War II, it became patently obvious to anyone who could read a balance sheet that rail passenger service was a loser. It still is. Amtrak doesn't make any money hauling people. None of the government-owned European railways make any money hauling people. Nearly every passenger-carrying railway is heavily subsidized by tax money.

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Railways *can* make money hauling heavy loads because of the low coefficient of friction of a steel wheel rolling on a steel rail. However, recent developments in highway trucking have also generated some real competition for that remaining aspect of profitable railroading.

However, this has not kept politicians, "futurists" and city planners from espousing the modern version of the Toonerville Trolley: the subway or the monorail.

A standard mental image of a future city that has been perpetuated by SF illustrators has a sleek, streamlined monorail trail thundering at you out of the vanishing point. In fact, this image became so engraved on the minds of future planners that some monorail systems have actually been built. And some urban light rail systems have been constructed in places like San Diego, Atlanta, and even Seattle.

City planners are making all sorts of claims for urban rail. None of them really stand up to close scrutiny in six separate areas.

First of all, railways don't reduce congestion on freeways and streets in the cities of the United States that grew up around the automobile. Most American cities are now suburban cities: a series of housing developments connected by shopping centers. The late author Louis L'Amour observed that the automobile is modern man's antidote to overpopulation. Expensive rapid transit rail systems in such cities as Cleveland and Boston diverted only about 1% of the passenger traffic from their freeways. Transportation planners estimate that only 1 car in 150 can be eliminated from freeways by light urban rapid rail transportation. And high population density is necessary to achieve even these modest gains. New York City has over 10,000 people per square mile and transportation routes are in tight corridors. If railways seem to be working, it's only because of the population density in America's Northeast Corridor, in England, and in Germany.

Railways built since 1950 have always cost far more than estimated. The Miami and District of Columbia rapid transit rail systems cost *four times* their estimated budget! The federal government's estimated per passenger mile cost for rail transportation is *ten times* higher than for urban freeway construction. According to a report by the Center for the Study of American Business, "The history of mass transit does not elicit optimism about its future. . . . urban mass transit is largely supported by state and local governments. . . . throughout its history, the federal transit aid program has offered local transit authorities a seemingly free ride, but the cost to taxpayers and transit patrons have proved to be too high."

As any railroad mogul of the past will tell you, fares will never cover operating costs. And not because of union wages, either. Miami built 20 miles of automated fixed rail which is losing $130 million a year. A former Administrator of the U.S. Urban Mass Transit Authority stated, "Cities blessed with 'free' rail lines have begun to regret their good fortune. Overly elaborate and costly, the new rail lines have borne only a fraction of the riders originally projected, creating huge deficits and straining city budgets."

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A special type of ridership is required for urban rail transit systems. The same for interurban systems. Riders must use it 4 to 5 days a week, going to and coming from the same locations each day. This may work in cities such as New York, Chicago, and Cleveland which have large downtown office complexes and one central group of office workers which must be transported to work and home again. Western cities are very decentralized. Furthermore, the centers are constantly moving because of growth. And the growth may not proceed the way the transportation planners expect. Miami is an excellent example of this. The Miami system was designed in the late 1970s from downtown to the southern part of Miami, but the growth took place to the north and west of the city. As a result, the Miami system can't deliver residents of low income central city neighborhoods to the northern suburbs where many of them work. Miami expected 200,000 riders per day; on a good day, it carries 34,000. (I've ridden on it for fun.) And this highlights one of the most important shortcomings of railways: They're inflexible. They can't be moved. As population shifts, railways can't take people where they want to go if the rails didn't go there first. Buses and vans can be rerouted to meet changing transportation patterns on a daily, weekly, monthly, and yearly basis.

Finally, politicians and planners claim that urban rail systems reduce pollution from automobiles. Look at the data already presented here. How valid is this claim? Especially if a rail system can expect to remove one car in 150 from the freeways. In the growing cities of the American Sun Belt, a rail system's effect on air quality would hardly equal that achieved by deferring one year's auto traffic growth! Only a 3% increase in the efficiency of auto fuels would more than equal the entire projected cost of nearly every projected urban rail system!

Given all of the above, why are cities continuing to plan for railways to solve their transportation problems? Why do we continue to support and subsidize railways in the United States, the land of the automobile and the jet airliner? Simply one word: politics. A large scale mass transit rail system of any sort offers a large number of short-term benefits such as construction jobs, a highly visible symbol of government "leadership," and "progress in civic improvement." For politicians, this is exactly what they're looking for; the apparent short-term benefits are well worth their small initial contributions. But the long-term considerations are of no consequence; they don't worry about being able to afford to operate the system in the future. After all, they can always raise taxes.

We'll see some futuristic monorails built, but I would be very surprised if they lasted more than twenty years. We'll see some subways built, including one in Los Angeles right through many earthquake faults down Wilshire Boulevard. And in the meantime, people will continue to get in their automobiles and go where they want when they want to go there. Oh, sure, the politicians can enact mandatory restrictions such as prohibiting you from using your car on certain days, depending on the last digit of your license plate, for example. To

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enforce these restrictions, they'll hire more policemen, which will cost even more money, which can be obtained only by raising taxes (because no politician in his right mind is ever going to cut back on any social program to balance a budget).

I can remember with wistful nostalgia the whistle of a steam locomotive. I suspect that our children will someday think that things such as passenger railroads exist only at theme amusement parks.

Trains are for poor civilizations that haven't yet progressed to the point where everyone who wants to own a car can have one . . . or two . . . or three. Or an airplane. Or the availability of low-cost long-distance airline fares on airlines with convenient scheduling.

Trains are also for those people who would rather live in the sort of cities where railways make sense but can never make money.

So I'm a nostalgic technophile who likes trains but who also sadly understands that we've grown beyond them. ■

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Janet Aulisio

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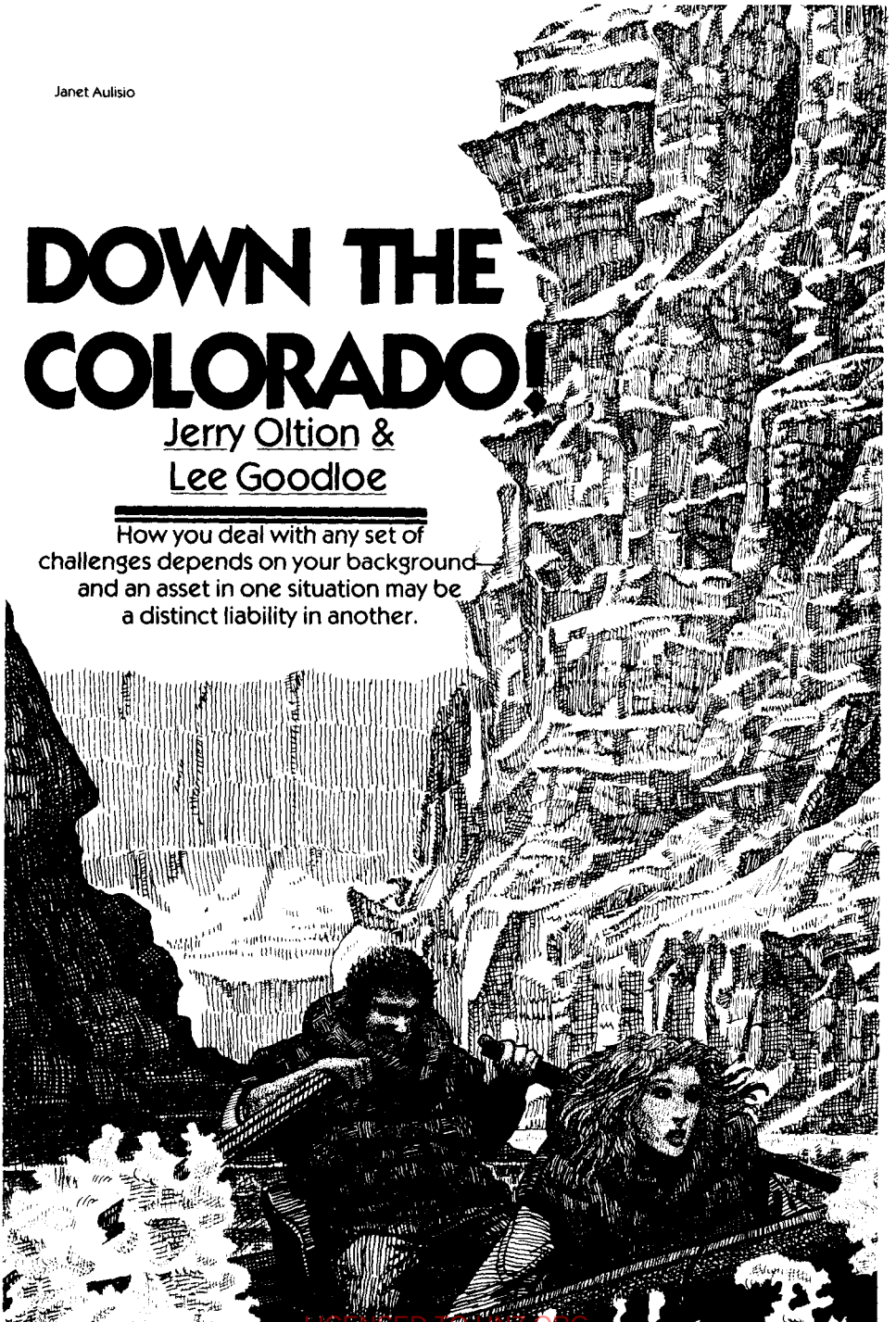
How you deal with any set of challenges depends on your background and an asset in one situation may be a distinct liability in another.



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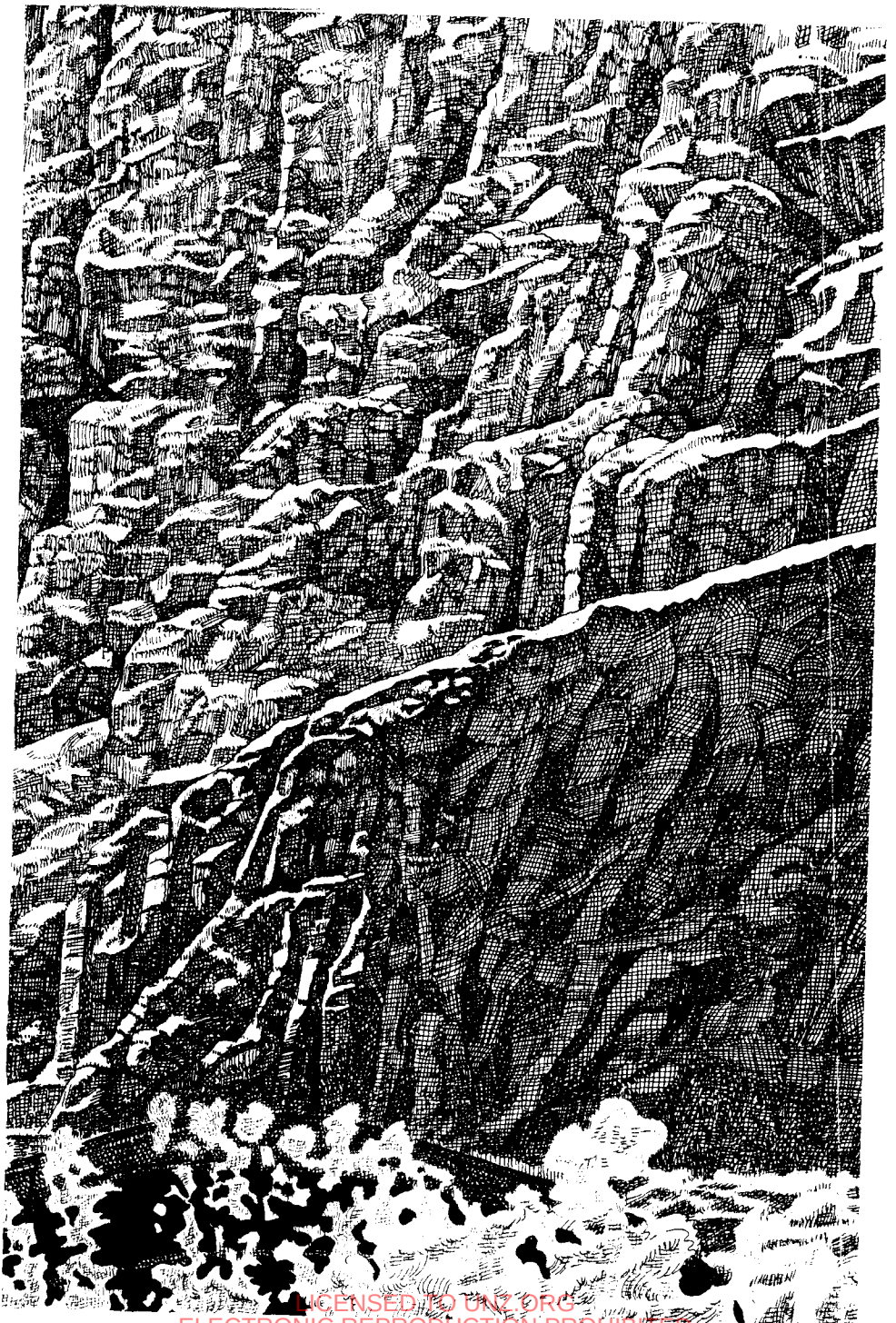

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And today's TOP CELEB STORY: From Alarm Bells to Wedding Bells! The most ROMANTIC result from last month's near-disaster in space! Andrea Nygren, the BEAUTIFUL assistant director, and Jaime Martinez, the DARKLY HANDSOME software chief of the ill-starred *SUNSTAT* were MARRIED today in a private ceremony! Friends say their romance blossomed during the TERRIFYING fall toward the Sun. Not since ROMEO AND JULIET has a love affair seemed more DOOMED! Only a FIERY DEATH in the solar furnace seemed to be their FATE! But through truly HEROIC efforts they managed to steer their crippled craft around the Sun, and Jaime and Andrea can now look forward to their JOYFUL FUTURE together!

The HAPPY NEWLYWEDS have refused to reveal their HONEYMOON plans, but *Space's Faces* has learned they will be traveling to Arizona's GRAND CANYON, no doubt in search of further adventure and thrills. . . .

—from a *Space's Faces* lead-in newsfax

"Hey, aren't you—?"

"No."

The pilot looked closer at his two passengers, the tall, tanned, burly, curly-haired man and the equally tall, pale, frail-looking blonde woman, and said, "Sure you are."

Jaime sighed. "OK, caught. We are. We did. We do. And we hired you to fly us to Lee's Ferry. Can we get going?"

The pilot visibly considered the question, but the sight of a silver balloon drifting its way over the fence beside the terminal building changed his expression from annoyed to conspiratory. "Press on your tail, eh?" he asked, and with a sly wink he added, "We can take care of that. Come on. Help you with your bags, miss?"

"Andrea. Thanks." Andrea held out one of her two duffels for him to take, then followed as he led her and Jaime toward the row of airplanes and helicopters parked out on the expanse of concrete behind the Flagstaff airport terminal building.

She examined their helicopter as she drew near. It was like no flying machine she'd ever seen. In the Settlements, the group of orbital habitats where she'd grown up, they had helicopters, but those were flimsy things made of graphite and nylon, with pedals driving the rotors. This looked more like a spaceship: massive, completely enclosed, and by the looks of the motor housing powerful enough to get into orbit.

The pilot opened the door on the right side. "Baggage goes in back," he said, tossing Andrea's duffel into a cubbyhole behind the back seat and relaying the others inside as well. He gestured for them to climb in, then went around to the other side and climbed into the pilot's seat. He began flipping switches on the controls and the instruments began coming to life. Tiny strobe lights began winking on the nose and the tail.

Jaime climbed in back. Andrea was about to follow and sit beside him but the pilot said, "No, sit up front here. You get a better view, and the weight distribution makes it easier to fly."

Andrea considered whether or not she wanted to be separated from her husband of only a few hours, but his enthusiastic, "Yeah, you'll love it!"

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decided her. "OK," she said, sliding into the front seat.

"So how long have you been dodging the snoobots?" The pilot nodded toward the silver balloons—now nearly a dozen of them—drifting toward them from the terminal building.

"Since we got here," Andrea said. "A week."

"They never let up," Jaime added.

The pilot nodded. "The price of fame. I usually figure it's justice in action, but in your case I guess you didn't ask for it. Well, I've sometimes wanted to dust the little buggers myself, so—" he flipped a prominent orange switch labeled "Main Bus" back off. The instruments died, as did the winking lights outside. He flipped on "Motor Start," then to Andrea he said, "When I give you the sign, flip the main back on, but not until I say so. OK?"

"Sure," she said, puzzled but willing to follow his lead.

The pilot winked at her and climbed back out of the helicopter. Suddenly raising his voice, he said, "I dunno, it acts like dead batteries. But don't worry, if that's the case we'll get 'em charged pronto. Won't take but a couple o' minutes." He opened an inspection panel, stuck his head inside for a moment, then said, "Aw, hell. It's worse'n that."

The media snoop robots— "snoobots" —had been holding back in anticipation of the prop wash, contenting themselves with long telephoto shots, but as soon as their remote operators heard the pilot's words they flocked toward the helicopter. They were little more than balloons with electric turbines for motive power and tiny holo cameras slung underneath for viewing their subjects. The balloon surface acted as a speaker for the remote reporter-operator's voice, and as they closed in Andrea could hear them all babbling at once. "Just one question . . . What seems to be the . . . Andrea, what are your . . . with the United Press . . . interview . . . worth your while . . ." and on, and on. She'd heard it all hundreds of times already.

The pilot's voice cut through the snoobot din. "Hey, wait, what's this?" He banged on something inside the engine compartment, then shouted, "OK, try it now."

Andrea obediently flipped the "Main Bus" switch. With a soft whine of power the motor began to turn, and the rotor blades began to swish around overhead.

The pilot dropped the hatch closed, jumped back inside, and gave the motor more power. The rotor spun up to speed quickly. The huddle of snoobots became a scattering of silver debris fluttering off in all directions.

"There goes the five o'clock news," he said, deadpan.

"Are you sure we want to do this?"

Jaime looked up from the spectacle below them: A deep, twisting slice in the ground, the eroded strata appearing like contours on a topographic map, was the Grand Canyon of the Colorado River. The pilot had banked the helicopter and circled to give them a better view of it.

Andrea was still looking, but it was she who had spoken. Jaime had heard that tone in her voice before. She was having second thoughts; she wanted to be reassured she was doing the right

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thing. "Sure we do," he said. "This is what we came for, isn't it?"

"I thought we came to be married."

The pilot said, "Married on the river? I thought you were married already."

"We got married this morning," Jaime said. "This is our honeymoon. We're going rafting for our honeymoon."

The pilot turned to look at Jaime over his shoulder, and with a twinkle in his eye said, "Buddy, what did she ever do to you?"

"What do you mean?" Andrea demanded. "Is it dangerous? Jaime told me it wasn't dangerous."

"Well, it depends on what you call dangerous," the pilot said, leveling out their flight and heading northward again. "Compared to almost falling into the Sun, I guess it's pretty tame."

"It wasn't really that exciting," Andrea said with forced nonchalance.

"Sure it wasn't," the pilot replied, but he didn't press it.

After a few more minutes of flight, he pointed ahead of them at a startling expanse of blue water nestled between red cliffs. "That's Lake Powell up ahead. Lee's Ferry is about fifteen kilometers below the dam there."

"Below the what?"

"The dam. Glen Canyon dam." He saw her puzzlement and added, "The lake's artificial. They use it to store water for irrigation downstream in the summer. And they generate power with it."

"Oh," Andrea said.

Jaime heard the suspicion in her voice and marveled at how quickly people's perception of what's normal can change. One generation in space was all it took; already a whole society had forgotten about flood control, irrigation, and hydropower. And why not? When they built the Settlements they put sprinklers along the axis for rain, and they generated power with solar cells.

Andrea wasn't really thinking about the dam. Looking out toward the lake was even more disconcerting than looking into the canyon. That preposterously distant horizon, with the planet perceptibly dropping away from her, below an open bowl of sky naked to the entire Universe. . . .

She shuddered. The very concept of it jarred reflexes ingrained by her Settlement background. It wasn't agoraphobia, not quite, but . . . those cliffs on the horizon, faded to blue by distance. How far? How tall?

Jaime noted her sudden silence. "What's the matter?"

"How do you stand this openness?" she asked, shuddering again involuntarily.

"*Stand* it? I love it! It keeps me sane to know there's still places where you can stand anywhere from here to the horizon without jostling another human being." He looked at her. "I thought you Settlers were supposed to think big. Don't tell me you're freaked out by wide open spaces!" He grinned.

"All right, I won't tell you."

Jaime mock-marveled, "Wait'll the shrinks get hold of this! I can see the title on the research paper now: 'The Settlement as Womb: Enclosure-Conditioning in Space Colonies.' " He chuckled, oblivious, sitting back and looking out the window again.

Andrea didn't reply. She sat with

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jaws clamped, simmering. Jaime *really* should know when to quit his teasing. She was all the more resentful because she knew her unease with the openness of a naked planetary surface was wholly irrational. She hated irrationality, especially in herself.

The pilot had politely stayed out of their conversation. Now he simply said, "We're about there," as he eased off on the rheostat and the helicopter began to drop into the canyon. Sandstone cliffs rose toward them, rose above them on either side, dwarfed them. Andrea tightened her grip involuntarily on the seat as the pilot brought them in close to a canyon wall, then banked sharply and dropped down with a flourish at Lee's Ferry.

The snoobots were waiting, lurking behind the safety of the buildings, but Andrea hardly noticed. She had eyes only for the river.

Jaime saw only the boat. "There she is!" he said, taking both their bags and striding off through the sand toward the pontoon boat waiting on the bank. "Hey, she's a beauty, too. I guess they believed me when I told them I knew a good boat from a beater. See, I told you it pays to marry someone with experience."

He turned his head to grin at Andrea, only then noticing she'd stopped to stare at the water and he'd been speaking to the air. He continued on sheepishly toward the boat, where a park ranger waited to greet him.

"I'm supposed to make sure you're familiar with the boat, Mr. Martinez," the ranger said. He smiled and waved his pocket computer. "Just a formality. I've already checked your record and I see you've worked as a river guide before, so I'm sure you know all about it. Besides, anybody who can pilot a disabled spacecraft around the Sun with only a shred of a light sail—"

"Observatory," Jaime corrected automatically. "Sunstat's an observatory, not a spacecraft, at least not in the true sense." He wondered fleetingly if the news media had some unspoken agreement that they would all work to twist the public's perception of an event as much as possible, or if it just happened that way by accident.

The ranger's smile lost a little wattage. "Well, anyway, I'm sure you're more than competent on the river, too," he said. "If you'll just go over this list point by point with me we'll have you certified to act as your own guide in no time."

Just a formality, Jaime thought. Uh-huh. If he hadn't shot the guy down it *would* have been. When would he learn to keep his mouth shut?

Long after the 'copter had departed, Andrea still stood on the river bank, hypnotized by the flowing water. At first she wasn't sure what to think of it. To begin with, it was more water than she'd ever seen close up. An entire habitat's worth flowed by every couple of minutes. It hardly looked like water, either. At some angles it was dark green, contrasting starkly with the mounded red dirt on the opposite bank: debris fallen from those red cliffs above. But at other angles—where you viewed the surface at the critical angle, she supposed—the water reflected, mirroring

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that same red dirt and the pale blue sky above it.

And it was *flowing*. The inexorable yet endlessly varying motion fascinated her. She could watch it for hours. It was beautiful, relaxing. So this was what Jaime had been talking about. This was why he'd brought her here for their honeymoon, so they could learn about one another in a place of serene beauty. Deep down, he had a more romantic heart than she had supposed.

"Andrea, what do you think of the canyon so far?" The voice came from overhead, distorted and about ten decibels too loud. Andrea looked up to the snoobot, wondering mischievously how the viewing public had gotten used to overhead camera angles. Were some people becoming renowned for their bald heads, or had the change in news-gathering technique precipitated a boom in the toupee market? How about hats? Big, wide-brimmed hats, and come to think of it, she'd seen a bunch of them in the airport gift shop. She'd thought the gaudy things were just tourist trinkets.

"What do you think of the canyon so far?" the remote operator's voice demanded again.

At first Andrea had tried to be polite to the media, reasoning that her and Jaime's notoriety could work to Sunstat's advantage when the question of continued funding came up during the next UN general session. But after a while they'd worn down her patience to the point she'd tried to out-stubborn them with "No comment" in answer to every question. Even so they'd never let up. Jaime had gotten mad enough to smash one to the ground just before the wedding, but the survivors had set up such a wail about freedom of the press and liability for damages that finally the two of them had admitted defeat and simply answered when they had an answer. "I think it's beautiful," she said. "Different. Majestic." And it also shut out those disturbing vistas, but she'd be *damned* if she'd tell them what she really thought of "wide open spaces." Settlements as wombs, indeed!

Jaime waved at her from beside the boat. It was still on the bank, and he was inspecting it section by section while someone in uniform looked on. Andrea supposed pre-flight checks were routine for any kind of craft.

The uniformed official, evidently satisfied with both the boat and with Jaime, logged something into his hand computer, then with a smile and a handshake left him to finish his inspection.

Jaime waved again. "Let me show you the boat!" he called to Andrea.

Andrea walked along the bank toward him, snoobots in tow. She'd had a vague notion that real water-type "boats" had to be streamlined, so she was a little surprised at the ungainly craft Jaime now showed her with obvious pride. It looked like a mockup of some sort of modular space station. It was made of two parallel inflated rubber cylinders about four meters long connected transversely with shorter inflated cylinders, the whole business being about two meters wide. A rectangular frame rested on top of the cylinders, and some kind of stiff webbing was stretched across the frame to make a platform. A single seat rose like a throne from the platform's center, and around its base were strapped

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four round-edged boxes that had to be storage compartments for food and gear.

Just as surprising as the boat's shape was its strong, volatile rubber smell. Evidently the boat was brand new and still outgassing solvents.

Jaime gave the guided tour while Andrea and the snoobots watched. As long as there was something interesting going on, the snoobots usually seemed content to watch unobtrusively, a tendency for which Andrea was grateful. She could tell from Jaime's excitement this was something very important to him, and she wanted to get it right the first time, without interruption.

He started right in with the naming of names. Long booms with flattened ends—"oars," Jaime called them, stressing they were *not* "paddles" —clipped over pivots jutting up from the frame on either side. The pivots also had a name: "thole pins." The seat in the middle was for sitting in while manipulating the oars; it was called the "rowing seat." (*Jargon, jargon, jargon!* Andrea thought. *As bad as spacecraft!*) To row you pulled the flattened ends of the oars through the water, Jaime said, and that provided thrust.

Andrea was nonplussed. "That seems kind of primitive. I thought we'd have hovercraft capability, at least."

Jaime shook his head. "No, Andrea, that's illegal. This is *wilderness*. No powered travel allowed." He pointed toward the back of the boat—the "stern," Andrea remembered—and added, "But we do have an electric outboard we can use in emergencies."

Andrea looked in vain for a motor large enough to lift the boat, then realized what Jaime was talking about. She'd taken it for just another piece of framework. After a moment's examination she could see how it worked: a streamlined fairing covered an electric motor with a propeller at the back. The motor was suspended on a vertical shaft so the propeller would be in the water during actual use, and obviously the shaft could pivot to change the direction of thrust. The entire device was ludicrously small.

"That's all?"

"That's it. And we won't even be using that. Brains, brawn, and luck —that's what gets you through the canyon."

Andrea looked back toward the river. Its dark flowing current had suddenly lost some of its beauty. No, that wasn't it. It had lost nothing; it had *gained* something, a sinister foreboding of perils to come. Once they ventured out upon it, there was no coming back. She was only half joking when she turned to one of the snoobots overhead and said, "I think I want to go home."

"OK, on the count of three. One, two, *seven*." Jaime gave a shove against the pontoon. He heard Andrea laugh, then felt her belatedly add her shove to his. The boat lurched a meter or so toward the water. "Again!" Jaime shouted, pushing harder. The boat began to slide, the pontoons gliding a couple of meters into the river before stopping again.

"Go ahead and get on board, and go up to the bow."

As Andrea scrambled over the framework, her weight helped lift the stern free of the gravel. Jaime gave a last push and leaped on just as the stern crossed the water's edge. The boat drifted out

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into the water and began to spin slowly around.

The rush he felt at being on the water again was just as he'd remembered it. "We're off!" he said, then raised a fist high and gave a rebel yell.

"So are they." Andrea said, pointing. He turned to see the floating snoobots following them out into the river, like a cloud of gnats.

He grinned. "Not for long, they aren't. Look." A dozen or more new flying robots, these red-tinged and somewhat larger than the snoobots, moved in from downstream. A deep voice seemed to issue from all the new 'bots simultaneously.

"Warning! You are entering a restricted area. Any attempt to advance farther will result in grounding and the levying of fines."

"Who are they?" Andrea asked.

Before Jaime could respond, another voice, this one coming from a rectangular box mounted beside the rowing seat, said in a matter-of-fact tone, "They are park rangers. They patrol the canyon in search of unauthorized activity or parties in trouble. They are colored to blend in with the canyon walls, thus reducing the visual impact of their presence. Some roam at large, but most are stationed in one place. Every big rapid, for example, has at least one ranger on permanent duty."

"Uh, thank you," Andrea said dubiously.

"You are welcome."

She looked at Jaime, and mouthed the words, Who was *that?*

He laughed. "It's a guidebot. The latest model. It's chock-full of information about the canyon."

"That is correct," the guide said. "I am programmed with *everything* you might want or need to know about the Canyon! History, geology, botany, zoology, ecology, and I can even predict the weather. Furthermore, I have advanced local intelligence and personality simulation so I can blend in just like another member of the expedition."

"Being a software guru has its rewards." Jaime grinned widely. "The old models weren't interactive, but I offered to beta-test this model so we got it free!"

Andrea looked dubious. Jaime shrugged. In truth, it was the only way he'd been able to finagle a reservation on the river. Earth's population had finally stabilized at nine billion, but that left few wild places to go around, and waiting lists were long. Worse, most of the people who did manage to get wilderness reservations had far more political clout than Jaime, and he'd been afraid right up to the last moment some senator would bump them from the list. Offering to perform a service in return for the trip had seemed a good way to assure they would actually take one. And besides, how much trouble could the guidebot be?

"Hey, let's get this show on the road." The boat had by now spun around and was pointing back toward the bank. Jaime sat facing Andrea on the rowing seat, grasped the handles of the oars, and heaved back on them. One wasn't quite deep enough and skipped across the water surface, sending a burst of spray toward the huddle of rangers and snoobots. He dug in again and rowed them out into the river. The snoobots didn't follow.

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"Do you always row backwards?" Andrea asked.

"Right. You can pull into the oars better that way. Get more thrust."

"But how do you see where you're going?" She looked puzzled. "There's no monitor. Surely *that's* not illegal, too."

"You don't need a monitor. You just look over your shoulder." Jaime added, teasingly, "You don't need electronics to do *everything*, Andrea."

Andrea replied, with some irritation, "You look over your shoulder in a *rapid?*"

"No, in a rapid you row back upstream. That's why it's set up so I'm facing the bow of the boat, so I can see where we're going. But anyway, in a rapid you're only rowing to have a little control. You can't fight the current. You'll see," he continued. "There's a little one right below here."

"Already?" she asked nervously. "Shouldn't we practice first?"

"It's just a riffle, really. No problem."

She looked around Jaime to see downstream. Her expression turned from anxiety to horror in an instant, and he suddenly wondered if he'd misremembered the river. Was there a bad one coming up already? He twisted around in his seat and looked downstream, and was relieved to see only the gentle riffle he had expected. A couple hundred meters away the smooth surface of the water broke up into waves, some of the larger ones capped with white, and Jaime realized that to Andrea they must look gigantic, though none was more than fifteen centimeters tall.

"It's all right," he reassured her. "Really. You won't even get wet. Just sit on the frame there facing forward and hang onto the handles beside you. That's it."

"What about seat belts?"

"You don't want to be belted into a boat. If it tips over, you want to get clear of it."

"Tip over? Wait a minute! That wasn't in the contract!"

"We won't tip over! Here we go."

Jaime pulled on the left oar, swinging the boat around until he faced downstream. Andrea sat below and in front of him, gripping the handles with white knuckles. He couldn't see her face now, but he could see her entire body quivering beneath her life jacket. He was about to chide her for overreacting, but checked himself when he remembered the first time he'd gone through an airlock.

The boat slid into the waves. Jaime left the oars in the water, pulling and pushing gently to keep them riding straight down the river. They bounced a little; some spray splashed up, but none landed in the boat and in a few minutes they were back in smooth water.

"Is that all?" Andrea looked almost sick with relief. She wore nearly the same expression now as she had when the falling Sunstat had rounded perihelion.

"That was noth—"

"That was the Paria riffle," the guidebot interrupted. "It was formed by the confluence of the Paria River with the Colorado. It is considered insignificant as a rapid; however, the difficult rapids farther on are formed by similar drainage conditions. Rapids are the re-

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sult of debris in the river channel breaking up the otherwise smooth flow, and a tributary creek is generally responsible for depositing such debris."

"*Thank* you," Jaime said, sarcasm dripping from his voice.

"You are welcome," the 'bot answered.

Andrea grinned. "Beta-test, huh?"

Jaime reddened and turned the boat around.

They drifted with the current, the canyon walls gradually rising above them as they did, and to her surprise Andrea felt herself relaxing. It wasn't just her fear of the rough water she was relaxing from, either; to have walls surrounding her again—even walls of stone—was reassuring, and she had to admit drifting with Jaime on a tiny boat in an immense wilderness was romantic.

It was also good to get away from the damned snoobots.

Jaime had climbed down off the rowing seat and was sitting beside her in the boat, resting his cheek against the top of her head and looking up at the sky.

"This is what a honeymoon should be like," she murmured, snuggling into him.

"You are honeymooners?" the guidebot asked.

"That's right!" Andrea said with enthusiasm.

"Then you might be interested to know," the 'bot said brightly in return, "that a honeymooning couple who went down the river in the 1920s—Bessie and Glen Hyde—drowned."

Andrea blanched. "*Really?*"

"Oh yes. But of course their equipment wasn't nearly so good back in those days. . . ."

Jaime sat up. "We don't want to hear any more about Bessie and Glen Hyde." He looked sheepishly at Andrea. "Obviously the program's judgment is off as to what to talk about when. Better log a note . . ." He opened one of the watertight storage compartments, got out his notepad and spoke into it. "Inappropriate response, mile—guide, what mile are we at?"

"Mile seven point eight five seven. Eight five eight. Eight five nine—"

"Enough!"

"Beta-test, huh?" Andrea said again.

Jaime grinned crookedly and raised his hands.

"So what's this 'miles' business? Kilometers too short for you?"

"Distances on the river are traditionally measured in miles," the guidebot answered. "Many of the rapids are named by their mileage down river, so rather than rename the rapids the Park Service decided to keep the old distance measuring system. Since the journey through the canyon is in many ways a journey through time, it was felt that the conscious anachronism would heighten the experience; however, if you wish, I could use kilometers henceforth and rename the rapids as we go."

"No, thank you," Andrea said. "We'll use miles." To Jaime she added, "Miles are cute."

"Very well." The robot dutifully continued its monologue. "If you look downstream, you will notice we are approaching the confluence with Badger Creek."

Jaime had been frowning at the robot; now he looked up, his eyes suddenly

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aglow. "Aha!" he chortled, rubbing his hands together melodramatically. "Badger Creek makes Badger Rapid, the first *real* rapid."

"Now would be a good time to assure that all your equipment is secured and that your life jackets are on properly," the robot said.

Jaime was already doing it. He snatched up the suntan lotion and the cold-can of Coke he and Andrea had been sharing, finished off the Coke, and tossed the empty and the lotion bottle and note pad back into the storage compartment. He looked Andrea up and down appreciatively, nodded, and said, "You're all set."

"I wish I was as sure of that as you are."

"You'll be fine. Just remember to hang on."

"I doubt I'll forget *that*." Andrea grinned nervously. As they drew closer she could hear a faint rumble, audible only because of the silence of the canyon. She felt her palms start to sweat.

Jaime gave the boat one more inspection, tugging on straps and double-checking that all the storage compartments were sealed, then climbed up to sit on the rowing seat with obvious anticipation. His face twisted in a silly grin.

"Ready?"

Suddenly the guidebot spoke up. "It is suggested that we stop to look at Badger before attempting it. You have not run the river recently, and may be out of practice."

Jaime, irritated by the constant interruptions—and possibly by the implication he was anything but perfectly competent—snapped, "Stop for *Badger*? You're kidding. Badger's no sweat, especially for an old river rat like me." He couldn't resist adding, for Andrea's benefit, "Really. Wait'll the rapids later!"

Andrea looked downstream again. The rumble was much louder now, and the current was becoming noticeably swifter. Not far ahead the river seemed to disappear abruptly. Every few seconds a burst of white spray would shoot up from below the edge.

She could still hear Jaime's voice over the roar. "Most rapids have a 'tongue' of smoother water pointing into them, where the main current flows," he said. "You usually just align the boat to run straight down the tongue, and that's all there is to it."

A flash of light ahead of them caught Andrea's attention. She glanced up from the river's edge, saw a silver balloon moving out from its place of concealment behind a rock, but before she could say anything to Jaime he shouted, "All right, hang on! Here we go!"

He gave another rebel yell, pulling back at the oars as the boat began to slide down the last stretch of smooth water before—hell. Andrea screamed involuntarily as they dropped down over the edge and she could see how the river broke up into a chaos of whitewater. It looked as if the entire river was boiling, surging up in waves, crashing back down with enough energy to smash their boat to pieces. "Stop!" she shouted, and Jaime did give a mighty tug on the oars, but he missed the water on the right side and the boat only spun around sideways.

The snoobot had maneuvered out over the river until it was straight ahead

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of them. Andrea looked straight into its holo camera and shouted over the roar of the water, "Get me out of here!"

It was too late. They hit the standing wave just below the tongue, hit it almost broadside as Jaime frantically tried to straighten the boat. Eyes closed, gripping the handholds for dear life, Andrea felt the boat buck mightily; then what must have been a ton of river water sloshed over the side. She gasped in shock, drawing in a mouthful of the stuff. It was *cold*. She'd never felt such cold.

The boat continued to spin crazily, sickeningly, lurching up and down, tremendous splashes of water covering them time after time, first from one side, then from straight ahead, then from the other side, over and over. Half of those times Andrea was sure she would be torn free and dashed to death in the river, and the other half she was sure the whole boat was going to tip over, but neither ever quite happened.

At last the battering began to let up. The roar began to diminish, and the waves, instead of trying to wash her completely out of the boat, simply drenched her again and again. The boat's frantic lurching became gentle rocking as the river spit them out into still water once more.

Andrea opened her eyes slowly. They were below the rapid, still upright, still spinning, but slowly now. She couldn't *believe* how cold she was. She coughed up half a liter of river, then looked up, expecting to see an empty seat where Jaime had been, but there he sat, oars in hand, that absurd grin still spread over his face. She looked away, back at the chaos they'd just come through, then back to Jaime.

At last she found her voice. "If you ever do that to me again, Jaime Martinez, I will—I will—" she couldn't think of anything horrible enough to threaten him with. Furious, she turned away, just in time to see a red-tinged ranger 'bot close on the snoobot she'd seen at the head of the rapid. A bright green lance of light shot out from the ranger, and the snoobot dropped into the water.

"Space, they're armed!"

"What?" Jaime asked.

"The rangers are armed! One just shot a snoobot back there."

"What snoobot?"

"The one that watched us almost get *killed*, that's what snoobot!"

"Shall I summon emergency medical assistance?" the guidebot asked.

"No!" Jaime shouted. "We're perfectly fine!" He took a deep breath, then went on more calmly, "Andrea, that's what running a rapid is all about. It's wet, yes. Cold, yes. Scary, yes. But it's *not* dangerous."

"Oh no? Then why was our expert guide so quick to summon 'emergency medical assistance?' " She gave the last words a little twist, like a dagger going in for the killing thrust.

"Because it's screwed up, that's why! There's no danger if you know what you're doing, and I know what I'm doing!"

"Strictly speaking," the guidebot interrupted, "We should not have entered the rapid sideways. We should instead have—"

"Shut *up!* When I want a critique of my boating technique I'll ask for it."

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"Fat chance of *that*," Andrea retorted.

"What do you mean?"

"What do you think I mean? You drag me out here on this damned freezing *river* and nearly get us killed—don't say you didn't—and you won't even admit you made a mistake!"

"All right. I made a mistake. I sent us down the rapid sideways. But we were never in any danger."

"No dan—"

"Listen to me. The whole reason for shooting rapids is for the rush you get. It *feels* dangerous. And I'll admit, it's riskier than sitting at home watching holovision, but we are not risking our lives here. Andrea, look at us! We got wet. That's all that happened."

"That's *all?* I'm freezing!" Andrea shuddered, only in part from the cold. Gratuitous thrill-taking was *not* encouraged behavior in the Settlements; there were plenty of ways to get killed in space without seeking them out.

"We can fix that," Jaime said. He got out of the rowing seat and opened one of the storage compartments, pulled out two enormous beach towels, and wrapped one of them around Andrea. He used the other to wipe the water from her face, trying, Andrea supposed, to wipe the anger from it as well.

"You could've at least warned me what it was going to be like," she said, clutching the towel around her.

"I said it was going to be exciting."

"Exciting, yes, but you didn't tell me it was going to be like *this!*"

"What, you wanted me to say, 'You're going to be cold and wet and miserable?' Would you have come if I'd said that?"

"No, and that's why you didn't tell me. You knew I wouldn't like it here, but you tricked me into coming anyway. You lied to me, Jaime Martinez. Well I'm not going to take that, not from you or from anybody. I want out of here. I want to get back into space, back to where things make sense."

Jaime looked shocked. He opened his mouth to speak, closed it again, opened it again, hesitated, then said, "I didn't lie to you. OK, I didn't tell you you'd be cold and wet and miserable, but I didn't think you would be, either. I knew you'd have some adjusting to do—everybody does—but I figured you'd learn to like it. I still think so."

"Learn to like it? Learn to *like* it? I—that's the most ridiculous—"

"Learn to like it," Jaime repeated defiantly. "That's right. You're not going to be cold and wet forever. You're already practically dry. And you're not cold anymore, either, are you?"

"I'm too mad to tell," Andrea said sullenly.

"Ha. Look, I'll make you a deal. Phantom Ranch is another eighty miles. That's two days. If you still don't like it by the time we get there, we'll call the whole thing off and go back to Sunstat. Deal?"

"Two days?" Andrea asked, incredulous. Two *days* of this?

"Two days. And I'll make you a bet, too. I bet by the time we get there you won't want to leave."

Andrea looked back at the rapid they had just run. How many more would there be? Ahead, the river looked smooth, but she wasn't fooled. No matter how beautiful it was now, there would be more. How could she possibly go through

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what she had just experienced again? She couldn't imagine two more *hours* of it, much less two days.

And then a darker thought came to her. Here they'd been married less than a day and were already fighting. On their *honeymoon*. Was this a preview of times to come? Maybe being married was going to be like rafting this damned river: mostly good times, punctuated by moments of sheer hell. If so, then she wasn't sure it was worth it. Standing there on the webbing at the front of the boat, shivering beneath her towel, she really didn't know if it was worth it.

Happy honeymoon, she thought.

"So what do you say?"

Jaime was worried. He had miscalculated badly, and he knew it. He'd known Andrea would be afraid of the first rapid, and he'd tried to spare her the weeks of worrying she would undoubtedly have done if she'd known what was in store. He had purposefully made it out to be less than it was, knowing full well the first time they actually ran a rapid she would be terrified, but counting on her relief at making it through unscathed to prove she didn't need to worry anymore. One brief moment of fear. He'd tried to shorten it to one brief moment, but instead of diluting the experience his efforts seemed to have distilled it, giving her the entire dose all at once.

No wonder she was mad.

But at the same time, Jaime couldn't help thinking there was another question here; did she have what it took to go on? Would she pull herself together and give it an honest try, now that she knew what was in store, or would she have the 'bot call in a helicopter and fly her out? This really wasn't like her experience on Sunstat, where she had bravely helped fly the crippled observatory around the Sun; there she'd had no choice. Here she could escape if she truly wanted to.

She looked as if she was thinking about it. Jaime waited for her answer. At last she nodded. "Two days," she said simply. She turned away and looked at the river, then back at Jaime. "That is, if we survive that long."

"We'll do better than that," Jaime said, reaching out to help her towel off. "We'll have fun, just you wait and see."

"How about a sing-along?" the guidebot asked suddenly. "I know lots of wonderful river songs which will cheer you up in no time." Without waiting for an answer, the 'bot launched into song:

"Row, row, row your boat, gently down the stream . . ."

For the first time, Jaime was glad to have the stupid 'bot along. He saw Andrea's frown fade into a crooked grin, and over the 'bot's three-part harmony he heard her say, "Beta-test, huh?"

"Gonna look at this one first, O river rat?"

They were nearing Soap Creek, the next rapid down from Badger. Andrea had finally burned off her adrenalin rush and was feeling almost civil again, though the thought of repeating the experience so soon had her stomach back in zero-gee already.

Jaime seemed irritated at the thought of actually stopping to inspect a rapid before running it, but he said, "OK. I

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guess so. There's a good place to tie up right at the head." He rowed them over toward the bank, and when the bow of the boat met the rocks Andrea jumped out with the rope and wrapped it around another rock. Jaime climbed off the boat after her, inspected her knot, nodded appreciatively, and asked, "Girl Scouts?"

"EVA training," she replied with a grin.

"Oh. Of course."

They could see the rapid just below them, but Jaime led off down the bank toward it anyway, scrambling over boulders and driftwood until he stood just opposite the tongue. Andrea climbed back on the boat and got the camera, took Jamie's picture with the rapid behind him, and followed.

"A rapid is really just a standing wave," he said when she reached him, raising his voice to be heard over the roar of water. He pointed. "See how the water moves through it? If you follow one spot in the current you can see it drop into the hole there below the tongue, then up the first wave, down into the next hole, up the next, all the way down. It's just like waves in an ocean, except here the water moves and the wave stands still."

Andrea watched, fascinated in spite of herself. The glassy green water did indeed turn into waves, waves that got larger and larger until suddenly their smooth surface broke into white foam, then diminishing again farther down as their energy spread out into the churning spray. Finally the current dissipated into vortexes, the water surging up from below as though boiling, bubbles breaking at the surface, only to disperse, to be replaced by another surge from below. The powerful flow of water was hypnotic. *Like muscles*, she thought.

And although ever-changing, it had rhythms; you could watch one of those standing waves build up and subside, build up and subside, and yet with differences each time. One time the wave rose so high it crested and broke; the next it merely swelled.

It was hard to be objective about Badger Creek rapid, but even so, this one seemed even bigger. It looked longer, faster, with more vertical drop.

"What we'll do," Jaime said, "is hit the tongue straight on this time, go *over* the waves instead of through them, and—"

"*We*, Kimosabe?" Andrea hadn't meant to say it out loud, but then again, maybe she had.

"What do you mean?"

Well, the subject had been broached, however clumsily. She said, "I mean, I think I'd rather walk this one. Watch you do it. Not that I don't trust you," she was quick to add, "but I really don't feel up to screaming my lungs out again just yet."

She watched him think it over. She could almost see him weighing the two quantities, cowardice and caution. She didn't know herself which was the stronger reason; all she knew was she didn't want to go through Soap Creek Rapid on the boat.

"I'll take your picture while you do it," she said. "We can blow it up and show everybody back on Sunstat how crazy you are."

Jaime's mouth twisted up into a slight smile. "All right," he said. "It's a

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fairly easy scramble along the bank here. Just watch out for snakes."

"What snakes?"

"Rattlesnakes, mostly. You probably won't see any, but keep your eyes out for them. Don't step without looking first, and if you hear a kind of a buzzing sound, stop."

"I'm going to hear a buzzing sound over that?" She pointed to the rapid.

Jaime shrugged. "Probably not. Just watch out for snakes. You probably won't see any. I'll wait at the bottom for you."

The mention of snakes changed the equation, but Andrea found the rapid was still the dominant factor. "All right," she said. She reached out, pulled Jaime toward her, and gave him a big kiss. "For luck," she said.

He smiled fleetingly. "Thanks."

She watched him walk back toward the boat, hoping she hadn't disappointed him too badly. Well, she would just have to get a good photo of him running the rapid.

She looked for a good vantage point, decided on a spot about a third of the way down so she could get a series of action shots as he passed. She climbed over the rocks toward it, scrambling for footing and batting aside the gray-green bushes that grew out over the water from the bank. Once away from the water, the fine dust her footprints raised had a dry, piercing smell that made her cough.

It was harder going than she'd supposed it would be. Once she stepped on a loose rock and fell, striking her arm painfully against a sharp edge of weathered limestone, and just beyond that she brushed against a cactus. She jumped back from the sudden stab of pain, missed her footing again, and felt another jolt of pain in the other foot as she twisted to recover her balance. The leg gave way beneath her weight, and she sat down hard on the rock, sustaining, she supposed, another bruise in a most uncomfortable place.

She sat on the rock a moment, recovering her breath. She had barely made it halfway to her chosen spot. She looked at her right foot, bleeding from half a dozen stab wounds from the cactus. Her right arm was an angry red from its scrape with the rocks. Her left ankle seemed unbroken, but it hurt when she rubbed it. No doubt sprained it, she thought. And to top it all off, her wet clothing seemed to be a perfect dirt magnet, rubbing uncomfortably on the few patches of skin that weren't already bruised. It felt as if the river were taking revenge on her for not riding the rapid with Jaime.

Where was he? Had she missed him, absorbed in her own problems? She looked downstream, but he was nowhere to be seen. She looked upstream and was relieved to see the boat just nearing the rapid. She stood, aimed the camera, and watched as Jaime guided the boat straight down the tongue. Just as he hit the first standing wave she triggered the shutter, getting a great shot of an immense cloud of spray, the boat almost invisible in it, and Jaime on top with the oars held high, his mouth open in a soundless yell. She followed him down, taking shot after shot, but she jerked back and nearly fell again when the viewfinder suddenly turned bright silver.

"Andrea, did you really mean what

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you shouted in Badger Rapid? Are you all right? Are you and Jaime breaking up?''

Of course. The press had planted a snoobot at each rapid. Andrea looked for the ranger 'bot that also had to be there, but when she finally spotted it against the rock, she could see that its attention was entirely on Jaime.

''What happened to your arm? You don't look like you're enjoying the trip. Why don't you tell us about it? We'll pay . . .''

She tuned the voice out. Stooping over as if to tie her shoelace, she picked up an irregular, fist-sized shard of sharp limestone, straightened, and hurled the stone at the balloon. It popped with a satisfying bang, and the snoobot dropped into the water. It seemed too easy—until Andrea realized snoobots weren't designed with defense in mind. The law was their defense—except in the national parks.

She looked back at the rapid. Jaime was below it now, working his way over to the shore, using the currents in the vortexes—''eddies,'' she reminded herself—to help move the boat where he wanted it. He was too far away for her to see his expression, but she knew what it would be. He'd run the rapid perfectly.

Andrea felt herself flush with sudden shame. Here she stood on the bank, battered and dirty and fighting off snoobots while he rode the rapid in perfect safety, and she had no one to blame for it but herself.

Obviously she was going to have to rethink a few things. For one, she was going to have to place more trust in Jaime. He was used to living on Earth; his experience had to be a better guide than her own panicky reactions and space-born reflexes. If he said it was safe to run the rapids, then it was probably safe. As for being fun, well, *he* certainly seemed to be enjoying it, anyway. Or would be if he thought she was. She supposed she should give it more of a chance than she had so far. Now that she was here, she should at least taste the experience, especially since it had been so hard to arrange. Even with their fleeting celebrity status, Jaime'd had to pull some major strings to finagle this private trip.

Her ankle hurt, but it still supported her weight. She began to work her way down through the talus and bushes to the pool at the bottom of the rapid where Jaime waited. OK, she thought. It's decided. I'll ride with him through the rest of the rapids. And when we get to Phantom Ranch, I'll—I'll—

She couldn't say it, not even to herself.

OK, she would decide what she would do then when she got there. But until then she would run the river with her husband.

''*Another* snoobot?'' Jaime, standing at the back of the boat so he wouldn't drip on Andrea while he toweled off, looked angrily up and down the canyon, but there were no silver balloons in evidence. He looked back to Andrea, wondering why she was grinning at such news. He didn't have to wonder long.

''I smashed it with a rock,'' she said.

Jaime felt a burst of surprise, pride following closely on its heels. ''You did? Good for you!''

Andrea grinned even wider. ''I felt

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like the mighty cave-woman or something. I mean, going after it with a rock. But it was all I could think of."

"Hey, don't underestimate rocks. Many a war's been fought with them."

"I just hope I didn't hurt Sunstat's public image by doing it."

"Not a chance. The people who vote money for Sunstat are always being pestered by snoobots; if the media is dumb enough to show you knocking them out of the air, then the people who count will applaud us all the more."

"Hmm. I hadn't thought of it that way. Maybe we should take a few rocks back to civilization with us."

"Maybe so." Jaime draped the towel over his head, took an end in either hand, and whipped it back and forth to dry his hair. It felt good to towel off. The Sun had slipped behind the western wall, and already it was getting cooler in the canyon.

With the towel over his head he didn't see that the boat was approaching the canyon wall. The first hint he had that something was wrong was when he felt the lurch as the bow struck the rock. Thrown forward by the impact, his instinctive response was to lean back. It was the wrong response. As the rubber pontoons compressed, the bow of the boat lifted upward. The stern dipped in sympathy, and suddenly Jaime, head still covered in towel, felt himself engulfed in cold foaming water. He shouted, "Hang on!" and attempted to follow his own advice, but he was already out of the boat, moving along in the current like a piece of driftwood.

The now-soggy towel clung to his head like a horror movie alien. He struggled to pull it off, to swim, and to draw a breath all at once. He heard Andrea shouting something, but couldn't make out her words nor the direction from which they came. Finally one of his thrashing hands encountered a corner of the towel and he gave it a yank that nearly pulled his head free from his shoulders, but at least he could see and breathe again.

A piercing howl from directly overhead split the air. What the hell was that? Jaime jerked his head back, but saw only open sky framed between high cliffs. The howl was deafening! Where was it coming from? It sounded like a siren of some sort, or—

Oh. His life jacket. Sensing total immersion of its occupant, the jacket had set off its homing beacon. And of course the beacon was placed in the one spot most likely to be above water: right behind his head.

Damn. Worse than damn. The beacon wasn't just auditory; a radio alert was going out as well. The place was going to be crawling with rangers in a few minutes if he didn't get out of the water. Jaime searched for the boat, finally saw it upstream, and began to paddle with backstrokes toward the edge of the river. Trying to swim was a losing battle against the current, especially since the life jacket held your head too high for a proper stroke, but he could at least help by working out of the main current into an eddy along the side. He could see Andrea frantically pulling herself toward the back of the now-spinning boat, going for the outboard motor. Good.

His view of her actions came in flickers, like stills from a movie, as he backstroked, then looked upstream, then

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backstroked again. Frame: The boat scraping backwards along the canyon wall, Andrea stumbling over the rowing seat. Frame: Andrea using the rock wall for support, lunging for the outboard. Frame: Boat lurching ahead against the current and Andrea nearly pitching overboard as she twists the rheostat all the way over. Frame: Boat slamming back into the wall again. Frame: Boat angling out into the river under power. Frame: Boat turning downstream. Frame: Boat aimed directly at him, accelerating. Frame: Boat turning again. *What the—?* Frame: Boat aimed away from him, under power.

He spun around and shouted, "What are you *doing?*"

"What do you think I'm doing?" Andrea screamed back at him.

"I haven't got a clue! Bring the boat here before this damned jacket calls the whole Park Service down on us!"

"I'm *trying*." Andrea tossed her head angrily, spun the boat around, and gave it full power again.

"Look out!" Jaime screamed, then lunged backward with a mighty stroke, kicking frantically as he did so. He felt his feet brush rubber pontoon, but thankfully not the propeller.

"Andrea, *here!*" he shouted, but he needn't have bothered. The siren was still doing its job. He struck off downstream while Andrea turned the boat once more and charged back toward him.

"Shut off the motor!" he yelled, getting a mouthful of water in the process.

She must have heard him anyway. Either that or she'd figured out what had happened the first time. The boat suddenly slowed, maintained its place in the current while he drifted toward it. He grabbed a ring near the bow as he came alongside, swung around, and raised himself enough to flop onto the transom like a soggy sack.

The life jacket siren gave a couple more wails, then shut off with a click.

For a moment the boat drifted. Jaime rose to a sitting position, water streaming out of his hair and jacket. He shook his head, clearing his ears of water, then with a sheepish grin turned to Andrea and said, "Thanks."

Her face was screwed up into a mask of anger. "Thanks, he says. No apology, no 'are you OK, Andrea,' no—"

"What are you so mad about? I'm the one who fell out of the boat."

"And you're the one who got mad at me for trying to rescue you!"

Jaime reached absently for his towel, realized it was on its way to Lake Mead by now, and sat down heavily on the rowing seat. "I'm sorry," he said. "I was mad at myself for falling off, and I looked up to see you going away from me and I guess I just shouted at you without thinking." He looked into her eyes, hoping to see some kind of affection there, but all he saw was anger. "I'm sorry," he said again.

Andrea turned away, angled the outboard motor until they began to spin around, then angled it back the other way and brought them to a stop sideways in the river. She swore, turned the motor to the other side again, and repeated the maneuver until they were aimed downstream again.

Jaime, watching her, could almost feel the click as the light bulb went on over his head. "Friction!" he said.

"Damn right there's friction," An-

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drea said. "There's been nothing but friction since we started this trip."

"No, no, I mean friction in the water. You're not used to friction slowing things down. Of course you spun it around; you were braking to a stop."

Andrea gave him a long, piercing look before she finally nodded and said, "That's what I thought I was doing. Evidently boats don't work the same way as spacecraft."

"Not quite," Jaime said. Spacecraft would drift with whatever velocity you gave them until you gave them another push to slow down. Jaime remembered how hard it had been for him to realize that when he first went into space. He knew it intellectually, but he couldn't feel it in his bones, couldn't make it a reflex. During seat-of-the-pants shuttle flying instruction he was always using too much thrust, always having to hit the emergency braking rockets to avoid colliding with his target, because space wouldn't slow you down the way water or air or the rolling resistance of tires on pavement would. No wonder Andrea, with the opposite instincts, had tried to slow down too soon.

Jaime stood up again, took Andrea's hands in his own. He wanted to wrap her in a bear hug, but he didn't suppose she would appreciate being pressed into a soggy life jacket. So he just held her hands and looked in her eyes and said again, "I'm sorry. I didn't think. You did wonderfully, really. I take it all back. Forgive me?"

Andrea's expression softened, fractionally, just enough so Jaime could see her fear surfacing under her anger. She nodded, said, "On one condition. You show me how to work this boat. You tell me what I should worry about and what not to. What's safe and what isn't. And you can start by telling me how you got thrown off the boat back there. That was *quiet* water. What happened?" She mimicked the slogan printed on the side of one of the most persistent snoobots: "Inquiring minds want to know."

The floor of the canyon was deeply shadowed. Only a bright strip along the top of the eastern wall showed that the Sun was still in the sky. It wouldn't be for long. Andrea, her sleeping bag draped over cold legs, watched the line of shadow creep upward while Jaime lit the campfire.

Their camp spot was a small section of sandy beach not far above House Rock Rapid. It was a popular place. They hadn't seen another soul on the river—only the rangers and the inevitable snoobots at the rapids—but now Andrea could see the flickering campfires of two more parties sharing the beach with them. She heard voices raised in song, laughter, calls for more beer from the boat. A flicker of silver suspended on a stick over the nearest fire explained the absence of snoobots in camp. Evidently the other people had no more liking for the invaders than she and Jaime did.

They had dragged their boat onto the sand as far as they could get it, then tied it securely to a large boulder. The river could rise during the night, Jaime explained. "Peaking power," he called it, and when she'd asked, the guidebot had explained that it was because of the hydropower plant in Glen Canyon Dam. The more power they needed to generate, the more water they let through.

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The high water line in the canyon was an artifact of the country's power needs. It had surprised Andrea to realize even this immense river was regulated by the whims of mankind. It surprised her and somehow comforted her. It made the river seem more familiar, planned and controlled, like the environment in a Settlement.

Jaime scratched a match against a rock and held the open flame below the pile of shavings he had made. Andrea watched him, fascinated, as he arranged twigs and small sticks to spread the flame, then added larger sticks and finally whole sections of split log once the fire had caught. The idea of coming here from a solar observatory hundreds of millions of kilometers away just so they could raft a few tens of kilometers of river and sit around campfires at night, made her smile in amusement. *We're not so far removed from all this, not in the grand scale of things*, she thought. *There's a little caveman in all of us*. The smell of the smoke seemed to arouse hazy, ancient memories, too, memories—or perhaps just fantasies—of being out on the savannah with humankind's ancient weapons against the predator-filled dark.

The open fire was fascinating. While Jaime got out pots and pans and began cooking dinner, Andrea watched the play of flames over the logs, wondering idly how much oxygen it consumed. She tried to calculate it in her head, figuring say, ten kilograms of wood in the stack left for them by the park service. Wood was cellulose, mostly carbon and hydrogen, some oxygen already in hydroxyl groups. . . .

Ignore the hydrogen and oxygen, then, and assume they would burn to water on their own. That left carbon, roughly half the weight of an organic macromolecule like cellulose. So call it five kilos of carbon burned in oxygen. That took, let's see, carbon has a molecular weight of twelve, oxygen sixteen, but it takes two for every carbon so that's thirty-two, that's about three times, so three times five is fifteen kilos of oxygen.

Fifteen kilos! That would keep a person alive for two weeks.

"Hypnotic, isn't it?" Jaime's voice cut into her reverie.

"Wasteful is what it is," she replied. "I just figured it out: that fire is using up two weeks' worth of breathing air."

Jaime laughed and looked up at the sky. Andrea followed his gaze with her own, saw it as if for the first time. Up there was enough air to cover the entire planet, enough to pressurize the surface under its own weight. Jaime said, "Don't worry about it. I'm sure there's enough to go around." He held out the fire-blackened cook pot. "There's plenty of dinner, too. Dig in."

The sky had darkened to black, sprinkled with stars. Jaime had seen them from space, without the atmosphere to dim them, but he still preferred them this way. From space they were cold, constant lights; from Earth they twinkled like living beings.

Andrea sat beside him, now wrapped completely in her sleeping bag for warmth, her back propped up against a rock and her head against his shoulder. The evening had gone well, better than the day had, actually, and now both of them seemed lost in thought. Jaime was

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thinking about what it felt like to be married. Now that he'd actually done what every kid swears he'll never do, he felt a thrill of excitement akin to the thrill he got when the boat just started into a rapid. Too late to back out, too late to do anything but hang on and enjoy the ride.

It had been quite a ride already. Up and down the scale of emotions, almost as if he and Andrea were testing their relationship to its limits on the first day. Jaime checked his watch, saw it was just after ten o'clock. Their wedding had been at ten that morning. Twelve hours.

"Hey," he said softly, "time to celebrate."

"Mmm?" Andrea asked, still off in her own world.

He leaned over and kissed her on the top of the head, then got up and climbed aboard the boat, rummaged through the storage compartments for one of the bottles of wine he'd hidden in his duffel bag this morning. He unwrapped the tape holding the corkscrew to the bottle, peeled off the lead, pierced the cork, and drew it out in a smooth pull to make a hollow *thunk*.

He turned to Andrea, expecting the sound of opening wine bottle to have drawn her attention, but she was still propped against the rock, face aimed to the stars, mouth slightly agape. Her breathing was slow and regular, and now that he listened Jaime could hear her gently snoring.

He looked from her to the wine bottle in his hand, wondering, should he wake her? This was their honeymoon, after all; there were certain . . . traditions to follow. Even so, he found he couldn't bring himself to disturb her sleep. He sat down on the webbing, leaned back against the rowing seat, and took a pull out of the bottle.

"Care for a campfire song?" the guidebot asked.

"Shhh! Low volume," Jaime said. "And no, I don't want a campfire song. Andrea's asleep."

"Oh." The 'bot paused. "How about a joke? I think I have one that would be appropriate for the moment."

Jaime rolled his eyes. *Why me?* he thought. Because he was supposed to be beta-testing the thing, that's why. Well, then, he supposed he should give it the test. "Fire away," he said.

"Do you know how Arizona foreplay is done?"

"No, how?"

"An elbow in the ribs and the phrase, 'Hey, you awake?' "

The robot waited patiently for Jaime's response. He chuckled wryly, blushing there in the dark. He couldn't fault the 'bot's ability to take a nonverbal cue. Hell of a note, though, that a damned robot was better company than his wife on their wedding night.

"Touché."

"How about the one about the deep space 'bot and the alien?"

"No."

"How about the one about—"

"NO," Jaime said. "I mean no thanks, but I'm not really in the mood for jokes right now." Just like a robot, not to know when to quit. He settled back glumly and took another pull from the wine bottle.

Andrea was faintly aware of Jaime snuggling up against her. Her sleep-filled mind fitted the sensation into her

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dreams, dreams of Sunstat as it dropped toward the Sun. After the main sail had collapsed they had jettisoned everything they could to lighten the load and get as much lateral acceleration as possible from their one remaining trim sail. They had tossed overboard beds, bedding, couches, chairs—everything they could do without—so it was no great feat of imagination to blend the sensations of sleeping on the ground with her head against a rock and Jaime beside her, into the memory of sleeping on the hard composite deck in the station with the rest of the crew beside her.

A faint breeze sighed fitfully down canyon. Tiny gusts puffed ashes from the now-dead campfire, fluttered her hair into her face. The noise of House Rock Rapid, just below camp, wavered in and out of her awareness as the vagaries of moving air alternately muffled and heightened its roar.

Suddenly the sensations all came together in her mind. She jerked upright. "Jaime!" she screamed. Another puff of breeze rustled her hair. "JAIME!"

Jaime mumbled, stirring halfheartedly, "Huh?"

"We've been holed! We're losing air! Computer, sound emergency alert, priority E-1 . . ." She pulled her arms free of the sleeping bag, searching frantically in the sand for an alarm button. Another gust tossed her hair.

"Whoa, Andrea, calm down. Andrea! It's just the wind." Jaime started laughing.

She stopped, looked around her, Sunstat fading from her mind. "The wind," she said at last. "Oh. Of course. It's just the wind, Andrea. Nothing to worry about, Andrea. It's just the worst fear a spacer has in her life, and you're *laughing*."

Jaime reached out and took her in his arms. "Hey, I'm sorry. I wasn't laughing at *you*."

"Then what were you laughing at?"

He considered his answer. "The situation, I guess. You had me scared there for a second. I thought I was back on Sunstat myself. Then I realized I was in the middle of the Grand Canyon and the relief made it seem funny."

"Well, it's not."

"No, of course not. I'm sorry I laughed. Come on, go back to sleep." Jaime leaned back, pulling her down with him until her head rested against his chest.

She listened to the canyon, to the sound of the wind and the water. She looked up at the canyon walls towering over them, dark against lighter sky. They no longer comforted her. Now they were spooky, indifferent cliffs with a gash at the top, wide open to space. And besides that, she was cold. There were no thermostats in the wilderness. Either.

"I don't belong here," she murmured into Jaime's curly chest hair.

"Sure you do. Go back to sleep."

She tried. She snuggled in close, holding onto Jaime and pulling her sleeping bag up over her head to muffle the sounds of the planet around her, but it still took a long time.

Their second day got off to a late start, and even after they got the boat packed and out on the river again the pace seemed slow. There was no reason for it to be that way—well, maybe there was, since Jaime hadn't felt so well that

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morning after finishing half the bottle of wine the night before. Still, there was House Rock Rapid just below their campsite, North Canyon rapid not far below that, then still more rapids in quick succession, most of them designated only by their mile markers; but even the rapids didn't break the quiet atmosphere on the boat. Jaime supposed he was to blame for that; he was being careful to run them all with a minimum of fuss, concentrating his—and Andrea's—attention on the smoother waters and beautiful surroundings of Marble Canyon. The guidebot chattered along interminably, but today Jaime welcomed its discourses on geology and vegetation types and historical trivia. The trip would have been pretty silent without it.

He couldn't read Andrea's mood today at all. She didn't seem to be angry, just quiet. She took the rapids with stoic determination, looked obediently at the sights the guidebot pointed out, agreed easily enough when Jaime suggested they use some of the quiet stretches to teach her how to handle the boat—but something was amiss and he couldn't quite put his finger on it.

At least they weren't being pursued relentlessly by the media today. Evidently they had given up after losing so many snoobots yesterday. Either that or the Park Service had cracked down on the operators. Whatever the reason, the only floating 'bots in the canyon today were rangers. There seemed more of them than before, but Jaime supposed his dip in the river yesterday might have had something to do with that. They must have doubled up to keep an eye on the greenhorns, he realized with embarrassment.

At last, just after noon, they encountered a sight that made even Andrea sit up in wonder. They came around a bend to see water gushing improbably out of a limestone cliff, emerging from a notch perhaps forty meters above the river and splashing down a steep slope draped with green. The lush vegetation offered stark contrast to the reddish-gray limestone walls surrounding it.

"Oh!" Andrea said from the front of the boat.

"Like it?" Jaime grinned as though he'd set the spring up himself, just for her.

"It's *lovely!*" Andrea said, true delight evident in her voice for the first time today. "What is it?"

"Vasey's Paradise," Jaime and the guidebot said together. Jaime laughed. "My turn to play tour guide," he said. "In fact, why don't we get off the boat and stretch our legs, explore a bit?"

"OK," Andrea said.

"Beware of poison ivy," the 'bot warned.

"Not to worry," said Jaime. "We've got Immunogen for that."

"Immunogen?" Andrea asked.

The 'bot answered before Jaime could. "Poison ivy contains an antigen which triggers an inflammatory response in human skin. Immunogen is a similar, artificial antigen which binds to the poison ivy antigen's binding sites without producing the inflammatory response, thus blocking the poison ivy's action. Immunogen is normally applied as a cream, and is often included as an ingredient in sunscreen lotion. I issued my warning about poison ivy because I no-

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ticed that you were not wearing sunscreen today."

"Oops," Jaime said. That's right, they weren't. Jaime wasn't because he, being dark complected, hardly ever worried about sunburn, and Andrea wasn't because she had never before been in an environment where she needed it. He'd remembered it for her yesterday, but today he'd completely spaced it, and so had she. He looked at her shoulders. Sure enough, they were red. Not seriously burned, but she would soon be feeling the heat there.

"Why didn't you mention that earlier?" he asked the 'bot.

It paused for long seconds. "I—don't know."

"Beta-test, that's why," Jaime said with a sigh. He took out his note pad and said into it, "Guidebot is not programmed to warn about overexposure to sunlight."

To Andrea he said, "I'm sorry. I wasn't thinking either." He dug into the storage compartment for the sunscreen and helped her rub it into her bare shoulders and back.

She didn't blow up. That was promising. All she said was, "So what can I expect to happen?"

Jaime was tempted to say, "Well, nausea at first, then your hair will start to fall out in patches," but he controlled the urge and said simply, "Not much. Your shoulders will feel kind of tender for a few days. If we'd let it go much longer you'd probably peel, but I don't think it's that bad."

"Oh," she said. That was all. Just, "Oh."

Jaime rowed them over to the bank while she put sunscreen on her arms and legs and face.

Their walk was short. Vasey's Paradise had suddenly taken on a different air. Beneath the lush foliage with its exotic aromas lurked a dangerous plant, or so Andrea believed, and even when Jaime found a sprig of it and crushed it in his hands to prove Immunogen worked, she wasn't convinced. Now she not only shied away from every plant, but from Jaime's touch as well.

He had intended to have lunch there, but now he decided against it. She wasn't comfortable, *wouldn't* be comfortable in Vasey's Paradise. They could eat on the river, or—yeah. Maybe she would like Redwall Cavern.

Redwall Cavern was not a cave, Andrea learned, but a large alcove weathered into the rock wall. They beached the boat on a sand bar, gathered their picnic supplies, and climbed up into the natural amphitheater. Andrea was glad to get out of the hostile sunlight, glad to be away from poisonous plants, and glad to have a roof over her head again, even a roof made of stone.

She looked at her shoulders. They were beginning to hurt. She supposed it was mostly psychosomatic, considering how soon it was after the burning took place, but she couldn't shrug off the fact that she'd gotten practically a lifetime's dose of UV in one morning.

Sunburn, poison ivy, freezing rapids—everything she encountered reinforced her conviction she was in a place where she didn't belong. She'd been raised in a completely controlled environment, an environment where everything, literally everything, right down

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to the bacteria in the soil, was there by human design. To come from that to this canyon, where she controlled nothing, seemed sheer lunacy.

How Jaime could like it, how he could actually *thrive* in such a place, was beyond her comprehension.

"You're awfully quiet, there, pilgrim." Jaime held out a wedge of cheese hacked roughly from the round with his pocket knife. Andrea took it from his fingers, instinctively looking it over for dirt, pocket lint, whatever else might have gotten into it in this all-too-natural place.

"You know, I don't think I've ever eaten a piece of cheese that wasn't cut geometrically perfect with a sharp knife," she found herself saying. "A special cheese knife. On a cutting block. And then I wash the knife and the cutting block and wrap the cheese back up and put it all away in the fridge before I eat the slice."

Jaime was wiping his pocket knife on his pant leg as she spoke. He stopped, grinned sheepishly, and said, "I guess this whole trip has been quite a shock to your system."

"Everywhere I turn I'm facing something new. It is a shock. I think I'm *in* shock. My brain feels like it's orbiting Mars. Twenty minute communications lag between mind and body."

"What can I do to help?"

"I don't know. Make it quit being so strange, I guess."

"I'm afraid that's one thing I can't do."

"I know. I'm sorry. I wish I could enjoy it. I really do. I know how much it means to you." Andrea bit into the cheese.

Jaime cut another slice for himself. "Don't worry about me," he said. "I'm not going to be offended if you don't like it here. Not mortally, anyway. I just wish you could see the beauty in it. Enjoy it for what it is."

"I don't know how."

"Just let yourself go."

Just let yourself go. Easy to say, but how to do it? It was like trying not to think of pink elephants. Easy, sure. Just don't think of pink elephants.

Andrea thought about pink elephants and about letting herself go while she and Jaime finished their lunch and continued on down the river. The canyon was getting even deeper now, the notch of sky overhead even narrower, and although it did feel good to have walls around her, she couldn't help thinking it would be even better if they weren't so . . . natural. Up, and up, and *up* . . . She craned her head back. Ledges, cliffs separated by steep slopes that might as well be cliffs, outcrops, all in variegated browns and reds and grays, all ragged, festooned with debris . . . and not so much as a centimeter of it human-made.

It was the pervasive sloppiness of natural formations that jarred her so deeply, she decided. Literally thousands of broken rocks were scattered over that cliff, some in precarious positions indeed. Green spots of vegetation also grew at random, some perched improbably within the cliffs themselves. It looked so *careless*. Even as she watched, a small rock bounced down from the heights, first spinning into space, then crashing into a narrow slope where its collision scattered a dozen more. Those stones in turn bounced and clattered, picking up astonishing kinetic energy

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as they plunged downward under a full one-gee of acceleration. Several finally splashed into the river a few tens of meters in front of the boat. She shivered momentarily. Suppose some such random rock landed on them while they were sleeping. . . .

Suppose a meteor took out a Settlement.

OK, so every place had its own dangers. It just went against her nature to put herself in the path of so many of them at once. And unfamiliar ones at that.

Well, one at least was becoming more familiar. The river seemed absolutely crowded with rapids, and another was coming up. Andrea dutifully went through the routine, taking off her life jacket long enough to strip down to her swimsuit, putting her sun-blocking clothes and anything else loose on the boat into the watertight compartments, then donning her life jacket again and hunkering down at the bow to ride out the waves.

Jaime took his position on the rowing seat. Andrea looked back at him while they were still in calm water, saw he was once again wearing his silly, death-defying grin. Even her mood couldn't puncture the sheer animal joy he felt when facing a rapid.

She wished she could feel that way about it. She really did. Just once, so she could share it with him.

Just let yourself go. Now, facing the foaming water, hearing its roar, his words seemed a mockery. Let go now and she was dead.

The boat began its trip down the rapid's tongue. Andrea sensed something was amiss, realized just as Jaime did that they were too far to the right, aiming off the tongue. Jaime pulled on the oars, the bow veered to the left, and the whole boat started to turn broadside. He made another powerful stroke with the oars, trying to straighten them out, but it was too late.

Still canted sideways, the boat smashed broadside into the V-wave at the edge of the tongue. An immense wall of cold river water broke over the boat's right side and slammed Andrea sideways. In a moment of pure terror she felt herself torn away, snatched off the boat as if she hadn't been holding on at all.

The universe became a chaos of foaming water. Waves slapped her, buried her, then she would pop out momentarily to gulp frantically after air, inevitably followed with a mouthful of river as she went under again. She waited for her life to flash before her eyes, but the only sensations that came were of water and disorientation.

Her head popped to the surface once again. She gasped in a breath, saw in a moment of clear vision that she was facing downstream—and something instinctive took over. Without stopping to think about what she was doing she brought her knees up and her elbows in. As suddenly as she had gone overboard, she was floating down the rapid under control, her feet and hands in front of her, her arms tucked in close, the life-jacket holding her head up. She rode up a wave that way, went under again momentarily as it broke over her at the crest, then just as quickly popped out on the backside, looking down into a valley of green water before the next wave. She dropped into it, slammed through the wave, then, laughing mani-

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acally, slid down into the next trough, over the next wave, up and down over and over again until she finally found herself at the bottom of the rapid, spinning around in an eddy, the life jacket's siren howling in her ears.

Jaime had managed to stay on board the boat. He was back at the stern now, using the motor to come to her rescue. When he drew close, Andrea couldn't help bursting into laughter again. The look of horror on his face was worse than Andrea's own must have looked just before the wave tore her from the boat. She watched his expression change through relief to confusion to amusement in separate, discrete steps, and she couldn't hold it back. He reached out and helped her on board, where she collapsed on the netting and laughed out a day and a half of fear.

"Mind telling me what's so funny?" he asked when the siren shut off and Andrea's mirth had subsided to hiccups.

"You," she managed. "Me. This whole silly business. I was waiting for my life to flash before my eyes." And she was off again.

"That's funny?"

"Space, what could be funnier? I mean, here I am bouncing ass over teakettle in the middle of *that,*" she waved vaguely upstream, "and I'm waiting for reruns?"

Jaime shook his head. "I thought you'd be ready to kill me for dumping you in the water."

"So did I. No offense, but I didn't have time to worry about you."

Jaime didn't look offended. "I'm glad," he said. "I'd rather see you smiling."

"Me too." Andrea shivered, but it wasn't from the cold. "I can't believe it," she said. "I actually enjoyed that, in a perverse sort of way."

"Imagine that," Jaime said, but there was no sarcasm in his voice.

Andrea hardly noticed he'd spoken. "It was just me and the river," she went on. "My whole universe was right there at my fingertips. My God, what a ride! I really did think I was going to die. And then when I didn't, when I knew I was OK, I felt practically reborn. I've never felt anything like that before, not even on Sunstat. Is that what it feels like for you?"

"Something like that," Jaime admitted. "I've never really thought about it in those terms, but yeah, that's the sort of rush I get from it."

Andrea couldn't stop grinning. Another shiver wracked her body. "Space, I think half my bloodstream must be adrenalin. Whoo!" She tossed her head, wet hair spraying water in an arc, splashing an already-soaked Jaime. "Yeah," she said, looking back up at the rapid. "Yeah, I liked that. Besides—" she grinned wider "—the cold water felt good on my sunburn. So how far to the next one?"

The snoobots found them just after they made camp. They had stopped on the north bank above Tanner Trail, on a broad, sandy beach Jaime remembered from times past. It was farther down river than they'd intended to camp, but neither Jaime nor Andrea had been ready to quit when they reached their scheduled stop. It didn't matter; they could camp anywhere they liked, and this beach was much better than the scheduled stop anyway. For one thing,

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it was deserted, which pleased Jaime considerably.

The whole day pleased him. Andrea's sudden change of heart was a wonderful surprise, though it wasn't completely unexpected. When he'd been a guide Jaime had seen the same sort of thing happen a couple of times a summer. The Francis Macomber reaction, he called it, after a character in a Hemingway story. Sudden personal danger, either real or perceived, could sometimes shake a person into a completely different world view. Sometimes the shift in attitude was permanent.

He had seen it happen before so he was not surprised at the phenomenon itself, but to see it happen to Andrea was still a bit of a shock. When he'd bet her she would learn to like the canyon he hadn't been counting on this at all. He'd expected it to grow on her slowly as she became more familiar with it, so she would remember it as a beautiful and unusual place, a unique memory to associate with their honeymoon —not as the place where she learned to stare her fears straight in the eye and laugh.

Worse things could happen, he thought.

As he worked on building the fire he noticed a phalanx of six or seven ranger 'bots moving toward them from upstream, but he gave them little notice. He and Andrea had a camping permit; they were perfectly legal. The rangers were probably patrolling for someone who'd gotten separated from their party. They moved toward him, and he was getting ready to say, "Sorry, haven't seen anybody," when an overly enthusiastic voice issued from one of the 'bots: "Mister Martinez! I'm from *Space's Faces* show, and we're doing a feature on you and Andrea!"

"I'm from *Interplanetary Inquirer* and so are we!"

"—*Arizona Sun*—"

"—*Bob's Morning Show*—"

"—*Star*—"

"—*Channel twenty-three*—"

"What are your—"

"—listeners would like to know—"

So that's why they hadn't seen any snoobots today! They'd been hiding out at the rapids, disguised as rangers. And as the boat swept past them they'd followed, until now there was a whole herd of them intent on adding a personal interview to their ill-gotten footage of the honeymoon couple on the river.

Jaime grabbed a piece of firewood and let fly. One of the snoobots went down, but the others danced out of range and continued their chant. Jaime considered chasing them down—they couldn't move as fast as a person on the run—but he didn't much like giving them footage of the hunt. That would sell as well as interviews. He wished he could've brought a pistol, but of course guns were illegal in a national park.

Rangers had guns, of course. The real ones, anyway. He could have the guidebot call them in to hunt down the snoobots, but that would take time, and besides, he'd rather solve his own problems if he could.

Andrea moved up beside him, put her hand on his shoulder. Jaime laughed wryly at the image they presented: husband and wife standing alone against the snarling beasts of the wilderness.

"Forget them," she said. "They'll stay out of range now anyway."

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"My range, but not theirs," Jamie said. "They've got telephoto lenses and directional mikes." They could probably back off a hundred meters and still watch every motion he and Andrea made and listen to every word they said. And there were a few words he wanted to say to Andrea in privacy tonight.

"I screwed up," he said. "I should've waited until I could get the drop on them all."

Andrea looked thoughtful.

"There's no need for hostilities," one of the snoobots called out. "We just want to show our listeners the happy honeymoon couple."

"Have you ever heard of the Heisenberg principle?" Jaime shouted back.

Andrea laughed. "Don't go over their heads, hon." She winked.

"What?"

"Don't go over their heads," she repeated. "You wouldn't want to get *above* them, if you know what I mean." Then, suddenly raising her voice, she said, "I think we should ignore them. I for one am not going to let them spoil my good time. In fact, I'm going to take my bath, just like I intended."

Jaime stared. "Huh? But that water's *cold!* You don't—"

Andrea winked at him again. Then she turned away and started rummaging through their gear, eventually emerging with the beach towel and a bottle of liquid biodegradable soap. Tossing the towel over her shoulder, she headed toward the upstream edge of the beach, toward the spot where a bluff of red Dox sandstone reached down to the water's edge. Water swirling around the rock outcrop had carved a pool out of the sand, and it was toward that pool she walked.

The snoobots scattered to either side of her, but she said, "What're you afraid of? Never seen a woman bathe before? Back home, public baths are common as snoobots. You aren't going to embarrass *me*."

She reached the pool, scouted around for a good bathing rock, making quite a production of it, Jaime noted as he watched from beside the boat. She finally settled on a flat rock just above water line, a rock that also lay conveniently below the sandstone bluff.

A bluff Jaime could climb without any problem, he saw, because in back of their camp it had broken down into a slope of large tumbled slabs, easy to scramble up. Jaime felt a grin spread slowly across his face as he realized what Andrea was up to. He began sliding cautiously away from the river and the snoobots.

Meanwhile, Andrea deliberately laid out her towel and soap, then took off her shoes, never looking at the snoobots. They had begun to drift over toward her. She stood up and removed her jacket, started to unbutton her blouse, taking her time. . . .

The snoobots were converging on her now like a dog pack on a crippled deer. Jaime scooped up a handful of round river cobbles, held them against his chest with one arm, then sprinted directly away from their camp to the tumbled slope. He scrambled up, the sandstone gritty under his free hand, and circled around to the top of the bluff overlooking Andrea. Crouched above her, he looked down on the tops of the snoobots. With their cameras slung un-

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derneath their balloons, they had no idea he was there. Andrea stood to his left, out of the line of fire. Perfect. He let fly with a stone.

A snoobot dropped abruptly into the pool, making a twin splash with the rock that had hit it. Two more 'bots fell in quick succession before the others, intent on Andrea's performance, noticed the fate of their fellows. The remaining 'bots began to scatter, but Jaime tossed two more rocks point blank and splash, splash!—two more robots plummeted into the Colorado. The last snoobot angled away, its tiny electric turbine straining to get it out of danger, but Jaime's rock struck it a glancing blow and it started to circle. He was about to toss his last rock, but even as he wound up for the throw it became obvious the damaged snoobot couldn't keep altitude, and was spiraling down slowly. He heard Andrea applaud as it fell into the pool and shorted out with a crackle.

Jaime climbed down off the bluff. Andrea was sitting on the rock again, putting her shoes back on.

"Not going to finish your bath?" he asked playfully.

Andrea cocked her head toward the pool, where the remains of the snoobots swirled around in the eddy. "There's stuff in the water," she said.

"Yeah, I guess we should take care of that. The jerks!" Jaime grumbled in irritation. "My wife shouldn't have to pull a striptease act on planetary TV just to get rid of the media." He found a stick and fished out the limp 'bots, smashed their cameras against the rocks just to be certain, then led the way back to camp, the 'bots dangling from one hand, his other holding Andrea.

"The mighty hunter, home from the kill," he said, tossing the smashed 'bots to the ground beside the fire.

Andrea clapped delightedly again. He started to grin.

"Feeling better about the trip?" he asked.

"Oh, maybe a little," she said. She ran her hand playfully along his back, and he remembered the other thing that came with the Francis Macomber reaction. He turned to kiss her, reached out and unfastened the last button holding her blouse, then started to loosen her shoulder strap.

Andrea yelped and jumped back. "Ow! That hurts."

With the pale skin between her breasts for comparison, her shoulders looked fiery red.

"Ouch!" Jaime said in sympathetic pain. "Your sunburn is worse. Didn't you put on more sunscreen?"

She reached up to touch her shoulders herself, and winced. "Just this morning is all."

"Damn! That's the problem. It washed off when you fell into the rapid."

"Well, nobody told me that would happen!"

"I know. I didn't think of it, and we know the guidebot wouldn't have. Hold on." He went back to the boat and rummaged in a storage compartment for the medical kit, reading the labels until he found a small tube of anti-inflammatory cream. Squeezing some onto his fingers, he gently rubbed it on Andrea's shoulders. She slipped her shirt down to let him reach her back, but it was a purely practical move and they both knew it. The mood had been shattered.

Later, after dinner, Jaime sat on a

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rock and stared gloomily into the campfire. Andrea had taken a painkiller and gone to bed already. *Here's to another romantic evening!* he thought wryly, uncorking the half-empty wine bottle and taking a swig out of it. So once again he got to swap jokes with a talkative robot. Wasn't marriage bliss?

"Hey, how about if I run this one?" Andrea asked. The familiar rumble of rushing water drifted up from downstream, the only sound to break the silence for quite some time. Jaime hadn't been very talkative again this morning.

Now he looked down from his study of the cliffs, astonishment evident in his face. *Hah, thought that'd get your attention*, Andrea thought.

"You want to?"

"Sure. What's this one called?"

As usual with such a specific question, the guidebot answered immediately. "This, the first large rapid in the Upper Granite Gorge, is named Sockdolager. It was named by John Wesley Powell's party in 1869, the first known expedition to successfully run the Colorado through the Grand Canyon. They named the rapid 'Sockdolager,' which is 19th century slang for a knockout blow, because there is no way around it on foot. The Powell party bypassed most of the large rapids by pulling their boats along the edges with ropes from the shore, but this one they had to run."

Jaime shook his head for the umpteenth time. But he added, "Just go right down the tongue. Be sure you hit it straight, though; there are some big waves right at the top."

Facing downstream, pulling on the oars, Andrea saw what Jaime had meant earlier when he talked about setting the boat and riding with it. The craft was simply too big to move much; all you could do was point it. She felt the water get swifter, saw the now-familiar edge ahead where river broke off into rapid, and her heart raced. A part of her still wondered *why* she was doing this, but there was now no time for second thoughts. . . .

The boat sailed down the tongue, which ran between two large waves cresting on either side, the water dropping into deep holes below. Aligned perfectly, the boat glided smoothly between both waves. Andrea looked momentarily into what seemed a cavern of green water off to either side, and then they were through, bouncing around in the smaller waves at the foot of the rapid.

"Great job, Andrea." Jaime beamed. "That was perfect! We didn't even get splashed."

Andrea felt a flush of pleasure. She got another inkling of the thrill Jaime derived from these wilderness excursions. It was not just a matter of surviving with the skill of your own muscles, it was a matter of *prevailing;* brains and finesse besting the raw powers of nature. She grinned wider.

Her successful run had seemed to shake Jaime out of his preoccupation. "Phantom Ranch is coming up soon," he said. "Do we stop, or do you want to go on past?"

"What do you think?" Andrea asked, still excited by her triumph.

"Want to keep the oars?" he asked.

She looked nonplussed for a minute, then said, "All right . . . if you warn me what's coming up."

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Jaime nodded, trying not to wince. *I really shouldn't have killed that bottle of wine,* he thought ruefully. But his headache couldn't dim his excitement now that Andrea was actually enjoying the trip. He hadn't really been as confident as he'd acted that she would want to continue once they reached Phantom. Even after her "Francis Macomber" experience she could easily have decided that she didn't need to prove anything more to herself.

But evidently she did need to prove at least one thing. "Can we stop for a while, though?" she asked. "I'd like to see a real human-made building again. Just to remind myself they exist."

Jaime smiled. "Sure."

"We are nearly there," the guidebot said. "If you look ahead you will see the footbridge leading to the ranch. It is the only crossing of the Colorado between Marble Canyon and Hoover Dam."

Jaime looked up to a familiar sight: a thin, low footbridge spanned the river, just high enough to clear the largest floods. But it looked bigger than he remembered it, or else—that was it. It was covered with people from edge to edge, and they seemed to be carrying a lot of equipment. Hikers? But those were weird looking packs. . . .

"Damn!" he swore savagely. "That's the press again, Andrea; they're lined up on the bridge. If we stop they'll be all over us."

"Looks like they're going to be over us no matter what we do," Andrea pointed out with characteristic logic, but she evidently shared Jaime's reluctance to step ashore into that crowd. She'd been edging the boat toward the bank in anticipation of landing, but now she rowed back out into the main current. As it carried them toward the bridge, they could see cameras and directional mikes bristling in their direction. "Could you please . . . how are you . . . from *Interplanetary* . . . what is . . ." The familiar babble, mercifully spared them since yesterday, rose to a roar again. As the boat passed under the bridge, Jaime stood and raised his middle finger at the assembled newsmen.

"That'll give them a photo for interplanetary feed," he said with a growl. He leered at the cameras, waving his single-fingered salute until they disappeared behind another bend in the river, but he felt no sense of triumph. The sudden return of the media threatened to shatter the morning's fragile euphoria. *Bastards!* he thought. *Why can't they just leave us alone?*

Andrea had been disappointed that they couldn't stop for a brief dose of civilization, but she lost her disappointment in her new-found skill at river running. Below Phantom Ranch they went through a sequence of large rapids in quick succession, Andrea still at the oars. She ran rapids with prosaic names like Horn Creek, Granite, and Hermit, and though she didn't run them all as perfectly as Sockdolager she was still proud of her performance.

The guide robot was chattering on again with more history: "The next rapid is named Crystal. It was created overnight by a flash flood. Before the flood it was hardly worthy of mention, but just over a hundred years ago a gi-

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gantic cloudburst at the head of Crystal Creek dumped over fifteen centimeters of rain in a few hours. A catastrophic mudflow roared down Crystal Creek, moving boulders the size of houses downstream to choke the Colorado. Now Crystal Rapid is one of the worst on the river."

"What's a cloudburst?" Andrea asked.

"A sudden intense rainstorm," the 'bot replied.

Andrea narrowed her eyes and looked from the robot's metal case to Jaime. "You're talking about atmospheric condensation, right? You get enough from one cloud to wash away *boulders*?"

"Sometimes," Jaime admitted.

"What happens to people down here on the river when that sort of thing happens?"

"Not so much as you might imagine," the guidebot answered. "The river level does not change significantly. But the Park Service advises that persons in side-canyons climb to safety up the canyon walls."

Andrea was stunned. "Climb the walls for safety? You're kidding."

"You would not want to be in a side-canyon during a cloudburst," the guide said, "but you need not worry. Such storms are extremely infrequent, and moreover, my weather prediction ability would give you ample time to be evacuated from the canyon entirely if such a situation were to arise."

"Great."

They drifted into the ominous pond-like surface that always presaged a major rapid. ("Of course!" the guidebot had said when Andrea had asked. "The rapid is actually the water flow over a natural dam, so there is always smoother water just above it.") Andrea could never tell when she was being told the truth and when she was getting a tall tale intended to scare her. "Should we look at this one first?" she half-teased, looking at Jaime.

Jaime looked uncommonly grim. "You know it. You *always* look at Crystal."

Andrea shrugged in an "OK, if you want to" sort of way and rowed them over to the right bank, where they tied up to a large boulder. Then they scrambled up the bank into the inevitable gray-green tamarisk thickets, bushwhacking downstream and then back to the river. Jaime forged ahead, but Andrea moved carefully, inspecting every bush and boulder first. Poison ivy and snakes she believed in.

It was still and hot in the Sun. A large fly buzzed by like a richocheting bullet. When she reached the river again it was distinctly cooler, and Andrea noted how even ordinary water had a distinct smell in air so dry.

They stared at the rapid for a while, letting the roar wash over them. Just the sound of it was all the confirmation Andrea needed. She'd thought she was used to big rapids by now, but this was something else: structureless white spray exploding from seemingly everywhere. An even larger mound of white foam swelled upward across from them near the opposite bank. She could now recognize it as a giant wave.

"That wave is . . . over six meters high," she estimated. "We're not going *through* that—are we?"

"No, we're not. We'll sneak around on the right." Jaime pointed downstream. "If you get too far left, not only

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do you go through the granddaddy of all holes, but you bounce through big waves all along the left bank. And if you go toward the middle you get stuck on that gravel bar." Where he pointed, Andrea could see rocks sticking up out of the water below the rapid.

"I think I'll let you row this one," she said.

Jaime nodded, smiling. "But you'll ride it through?"

Andrea felt herself blush, remembering her walk around Soap Creek. "Hey, you can get used to anything," she said. It was surprising, but she really wasn't all that worried. She really was learning to trust Jaime's experience, and if he thought it was safe to go through that, well then, it must be safe. It *looked* like certain death, but this whole trip had been nothing but surprises; why should this be any different?

Despite its appearance, Crystal wasn't as tough as Jaime had remembered it. They bounced and splashed and whooped their way through it, but the thrill he felt was hardly any greater than on many of the other big rapids. He wondered if it was the rapid or his memory of it that had changed. Possibly both. *Time and the river change everything*, he thought. In another hundred years Crystal might be just a riffle again, and his and Andrea's grandchildren would never believe his stories about the thirty-meter man-eating waves that were there back when he was young.

He turned the oars over to Andrea again, drifting away in thought. Would they have grandkids? he wondered. Not on Earth, they wouldn't. The Solar System was just beginning to open up; there would be room for them in new Settlements, but Earth was still overpopulated and would be for centuries, if not forever. The Reproduction Bureau would never allow the children of a Settler marriage to live here.

So, their children would be Settlers. Which meant that Jaime would be spending most of the rest of his life in space. This might very well be his last time through the Canyon. He'd known intuitively that marrying Andrea would mean living in a Settlement, but he hadn't truly *felt* it until now. It was a sobering thought.

"Jaime?" Andrea's puzzled voice cut through his reverie.

"Hmm?"

"I think I'm stuck."

Jaime looked up. They'd just ridden through a minor riffle, but now they were off to the side of the river, caught in a vortex off the main current. They spun around and around, going upstream next to the bank, where a gneiss bluff dropped into the water, then back toward the middle of the channel. As the eddy approached the main current, however, the current pushed the boat back toward the bank and the cycle began again.

Jaime had told Andrea how to get out of an eddy with just oars, how to row like crazy when they were heading out into the river in order to break through into the main current. Now he tut-tutted teasingly. "What's this? An old river rat like you getting stuck in an eddy?"

Andrea said nothing, lips tight. She waited until they went around again, positioned the boat, and leaned into the oars. The boat moved sluggishly ahead, but not with anything like the speed they

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needed to break free. On the next pass Jaime started the outboard and spun it around to pull the boat in the same direction as Andrea rowed, and the extra thrust easily pushed them back into the main current.

"Failed your quiz, Andrea," he said. "You're not supposed to have to use the motor!"

He shut off the outboard and looked up, saw too late he'd overdone it. Again.

"You sure seemed to think it was a good idea when I pulled you out of the river in Marble Canyon!" Andrea snapped.

"You're right," he said, contrite. "I was just teasing. It really doesn't matter. I'm an insensitive jerk and I don't compliment you enough. You're really doing wonderfully. In fact—"

"OK, OK," Andrea said, "don't wear it out. Look, I'm getting tired, that's all. We've been on the river all day. Why don't we look for a place to camp?"

"Good idea," Jaime said, and he wasn't just being agreeable. He was getting tired, too. He had visions of a quiet, flickering fire, two warm sleeping bags zipped together, and a long, snuggly time until morning.

They beached the boat on a deserted stretch of sand at the mouth of Shinumo Canyon. As Andrea stood beside the boat, stretching and working the kinks out of her muscles, she saw a new sight down river. A mottled wall of gray and black rose up into the sky, towering even above the canyon walls.

"What's that?" she asked innocently, pointing.

Jaime looked where she was pointing. His eyes widened in surprise, and he said, "That's a thunderstorm approaching. Guide, why didn't you warn us?"

"The probability of the storm reaching this area is less than certain. In fact, I calculate only 93.4 percent chance of it."

"Ninety three percent! Good grief, what do you want?"

"Certainty, obviously" the robot replied.

"Beta-test," Andrea chanted.

"Beta-test," Jaime agreed resignedly. "We'd better get out the tent."

"Tent? Shouldn't we be climbing the canyon walls?" Andrea asked, only half joking as she looked back up the side-canyon behind them from which Shinumo Creek innocently trickled.

"Not necessary," the guide replied. "I have contacted the Weather Service, and they estimate the storm will leave less than a centimeter of rain. That amount will not be dangerous."

Andrea looked to Jaime for confirmation. He nodded, grinning now. "It'll be fun," he said. "Thunderstorms are like rapids, only different."

Yet another new experience, Andrea thought resignedly as she helped Jaime set up the tent. It was a clumsy bundle of synthetic fabric and composite fiber rods, which they assembled under Jaime's direction. The rods fitted into sleeves stitched along the tent's outer surface, stretching the fabric into a dome shape not unlike the bubble shelters used on the Moon.

A breeze, surprisingly cool, puffed fitfully, and a few tentative drops of rain raised dust. They threaded the last of

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the rods into their fabric tubes, popped the ends into the receiving grommets, and held the assembled tent between them as they looked for a good place to stake it down.

A sudden gust of wind—stronger by far than the breeze of a moment before—tore the end out of Andrea's hands. It twisted out of Jaime's grip as well, lifted up in the air, and flew out over the river, where it settled lightly onto the water. Bobbling like a cork, it moved off with the current.

"Damn it!" shouted Jaime. He stood with fists clenched, watching the tent dwindling downstream. "Damn, damn, damn!"

Andrea left him at it, scrambling alone to collect their other gear scattered by the gust. Clothing and dehydrated food envelopes from the open storage compartments now decorated the tamarisks surrounding their beach, and she wasn't about to lose them all.

The wind came again. Driving water now accompanied it, cold drops moving almost parallel to the ground. The rain had begun in earnest. Andrea shivered. This was as bad as being soaked by the river! Worse, actually, because the Sun wasn't shining. And what would they do now that their tent had blown away?

A flash and a terrific crash echoed between the cliffs, and Andrea shrieked involuntarily. The flash left a purple afterimage stabbing across her field of vision, but she could still see a smoldering bush on the opposite cliff where the lightning bolt had struck. Andrea made a lunge for one last item—their single remaining towel—and headed back for the relative safety of the boat.

Meanwhile, still swearing continuously, Jaime had dug into another compartment and extracted a large plastic tarp. He handed the folded bundle to Andrea—"And *don't* let it go!" he shouted over the wind—while he tied one edge of it to the pontoon of the boat on the side that had been pushed onshore. He weighed down the other edge with rocks while Andrea, her teeth clenched, doggedly held onto one of the free ends. The other side flapped madly in the wind, but Jaime soon had that weighed down as well. He tossed another tarp and their sleeping bags and their cooking kit underneath their crude lean-to, spread the tarp out as best he could, and then directed Andrea to crawl under. He followed, pulling the last flap down behind him and weighing it down with the cooking kit.

Huddled under their makeshift tent, soaked to the skin, they listened to the rain pour down. Andrea watched a drop of condensation on the inside of the tarp swell and then suddenly run down, leaving a trail of tiny beads behind it. It joined a spreading patch of dampness on the floor. Between the condensation and the inevitable leaks, the relatively dry area in the center of the tarp was inexorably shrinking.

She remembered times in the Settlements when she hadn't looked at the rain schedule and had been caught outside when they turned the sprinklers on. But you were never far from shelter in a Settlement! Nor was it so windy, or so cold. "It's hard to tell where the rain stops and the river begins," Andrea said, shivering.

Jaime grunted. Andrea knew what he was thinking. His visions of a quiet, romantic evening, snug and warm while

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the rain pattered futilely on the outside of the tent, had vanished along with the tent.

Well, he was the one who had suggested coming here; if it wasn't suitable for honeymooning, that was hardly her fault, was it?

She stuck her head outside to look at the storm. It had settled down to a steady rain now, punctuated with flashes and crashes from the lightning. Here and there, trickles of water were tentatively creeping over the opposite cliffs, dimly visible through the sheets of rain under the strobe-like illumination. Watching them, Andrea shivered again. "What about flash floods? Jaime, what about a flash flood? This is what makes them, right?"

Jaime grunted again. "No. Not likely, anyway."

Not likely, she echoed mentally. *Well, thank you, Mr. Martinez. That's very comforting*. She felt bad about losing the tent, too, but dammit, that wasn't her fault either, no matter how much he seemed to think it was. Besides, she was just as uncomfortable as he was, maybe more so since she didn't have any experience in coping with these weather conditions. Jaime could certainly do with a little patience as far as she was concerned. He seemed genuinely angry when she wasn't instantly an expert at things he'd done all his life.

Oh, just stow it, Andrea, she thought. *You're tired. He's tired. And you were both enjoying it earlier today*. She pulled her sleeping bag up around her and finally she fell into a fitful doze, curling up closer and closer into a fetal ball, unconsciously trying to follow the dwindling dry area. When her dreams came, they were of climbing the impossibly steep canyon walls while a roaring flash flood rose just at her heels.

Dawn broke bright, clear—and silent. Wretchedly uncomfortable and still dead tired, their wet clothing clinging like shrink-wrap plastic, they staggered around the camp like zombies, slowing packing up. Andrea asked innocently about a campfire, but wasn't amused when Jaime asked if Settlers knew how to burn wet wood. He was immediately sorry he'd said it, but it was too late now. After that she said nothing. Even the guidebot had the sense to keep quiet.

As the morning wore on and they dried out, though, their spirits slowly began to rise. By midmorning Jaime felt confident enough to attempt a reconciliation. And the perfect place for it was just coming up. He rowed over to the left bank, below a sidecanyon, and tied up to a gigantic boulder. Looking around, he said, "We're in luck! Nobody else is here right now. This is a popular spot."

Andrea had been dozing in the Sun, this time with the benefit of sunscreen. "Where are we?" she asked, sitting up to see around her. Drying clothing and gear bedecked the boat.

"Elves's Chasm," Jaime said quickly, for once getting the jump on the guidebot. "It's really pretty." He helped Andrea out of the boat, took her hand, and with beach towel in the other led off up the slope.

Perhaps fifteen minutes later, he asked, "Well, was it worth the scramble?"

Andrea looked at the giant travertine boulders jumbled higgledy-piggledy in

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the narrow canyon. Trickles of water threaded between them, dropped shining strands into deep, clear pools, their edges decked with dark green moss.

"It's kind of artsy," she said. "It looks like some of the mini-parks we have in the Settlements."

Jaime dropped the towel on a rock and waded out into a pool. "The water's warmer than the river," he said. "Come on in." He let himself fall over backwards, kicked off, and did a lazy backstroke across the pool.

He watched Andrea step into the water, hesitantly at first, then more enthusiastically when she realized just how much warmer the water was here. She made a shallow dive from knee-depth, her sleek, swim-suited body arcing smoothly into the pool, and swam over toward him, veering away when he splashed a handful of water playfully in her direction.

She splashed back, laughing. Jaime splashed her again, harder, and suddenly they were in the thick of a waterfight. Palms held forward, arms moving like pistons, he advanced on her, guided by her shrieks of laughter and the wall of water she returned to him. He made a sudden lunge, wrapped his arms around her waist, ducked, twisted around, and had her spread across his shoulders before she could struggle free.

"Hah, got you now, woman!" he shouted.

"That's what you think." Andrea had one leg free; she used it to tangle Jaime's legs and they both went down in an enormous splash.

They came up nose to nose, dripping water, glowing. There was a brief hesitation, a *this is it* sort of moment as if they were kids on their first date, then suddenly they were kissing intensely. Jaime slid his hands around her waist, caressed her back, began to carefully peel the straps down over her sunburned shoulders—

He stopped. Something metallic glinted in the sunlight across the pool from him.

"Oh, Christ." Pulling away from Andrea, he sloshed out of the pool to the device that had caught his eyes. It was a tiny box glued to the rock, a box with a camera in it.

"What's the matter? What is it?" Andrea asked, coming up beside him.

"Scapescanner." Jaime grimaced. "The Park Service licenses them. Broadcasters set them out and sell real-time videos to people who want a window into the wilderness. But I never thought they'd wire *Elves's Chasm*. Bastards! We just put on quite a show for a bunch of North American offices and living rooms."

He caught her unspoken question, answered. "No, they generally don't have audio pickup."

"I guess we can just drape the towel over it then, can't we?" Andrea asked playfully.

"They know we're here," Jaime said.

"So?"

"What do you mean, 'so?' Everybody will know what we're doing!"

"So?" Andrea repeated. "That doesn't make it any less fun, does it?"

Jaime considered her question, knowing he was being overly modest by her Settlement standards, but it wasn't something he could consciously control.

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"I'm sorry," he said, "but for me it does."

Andrea sighed deeply. She stared into the lens of the camera before them, raised a hand to wave at it, and said, "Hi, Mom."

"Come on," Jaime said, mad at his own failing, mad at the world. He stomped around the pool to retrieve the towel. "Let's get out of here."

Andrea was once again on the rowing seat. "What's the next rapid?" she asked Jaime animatedly, hoping to draw him out. He hadn't been talkative since the Elves's Chasm stop.

The guidebot chimed in as usual, before Jaime had a chance to answer. "Bedrock," it said.

"Anything I should know about it?" she asked, taking a slow pull on the oars just to feel their resistance.

"Stay way to the ri—" Jaime began.

The guidebot interrupted again. "You must run Bedrock by staying very far to the right. Most of the flow swings off to the left in a very tight turn around an island, and if you get too far to the middle you will get stuck in that current. Then you can't make the turn. However, part of the flow bypasses to the right, and if you stay over there you will have no trouble.

"The island, and the curved channel itself, are carved into the gneiss bedrock. That's how the rapid gets its name," the robot added unnecessarily.

Jaime had shut up in resignation and let the 'bot chatter on.

"Shouldn't be any problem, then?" Andrea asked merrily.

"I guess not," he responded morosely.

Andrea carefully rowed rightward, her space-trained reflexes unconsciously misguiding her. She had relaxed too much around the boat; she was thinking of it almost as a funny-looking spacecraft by now. Intellectually she knew that boats were subject to friction—she'd noted that many times this trip—but it still hadn't sunk into her reflexes. And she was now at the point of beginner's overconfidence; she had rowed enough to relax her caution, but not enough that she could trust her instincts.

Another pull on the oars, another increment of delta-V. *Hmm*, she thought. *We still seem awfully near the middle of the river. I guess I'd better give the oars one more pull. . . .*

Jaime suddenly realized what was happening.

"Andrea! What are you doing? Row! Row to the right! ROW TO THE RIGHT!" He scrambled for the outboard, but he was too late. The main current had caught them, and now they were being carried more and more swiftly to the left, heading into the tight turn where the Colorado crashed through dark gneiss. Andrea, terrified, continued trying to row, but her eyes were fixed on the white water churning against black rock ahead. Jaime just hung on grimly, ready to jump if need be.

The boat swung around in the wild whitewater. Unable to follow the curve, it slammed into the outside wall, the oars whipping around as the boat crunched onto the rock. The outside oar splintered audibly and the boat tipped far over. Jaime braced himself for the inevitable overturning, but instead the

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boat ground to a complete stop, trapped, held in against the canyon wall by the force of the water flowing past.

Jaime had shut his eyes involuntarily when they collided. He opened them gingerly, to see the right pontoon completely submerged and river flowing through the middle of the boat. To his relief, Andrea still clung to the rowing seat, clutching the shattered oars, evidently unharmed. How about himself? Could he move? He tried, discovered nothing broken, though blood welled from a shallow slash on his right arm.

Andrea hadn't budged. "Andrea!" he yelled. Her eyes remained tightly shut. Although she was less than two meters away, it was hard to shout over the rapid's roar. "ANDREA!"

He saw her stir, open her eyes. "Are you all right?"

Another stir. "I think so."

"Be sure!"

More tentative movements. "Yeah, I'm OK."

Jaime looked upward. The rock wall they were lodged against was only about three meters tall, breaking away above into a relatively flat surface. "I think we can get up there," he shouted. He climbed over to the rock, cautious on the wet rubber. The gneiss was deeply fluted by millennia of flowing water, so although polished smooth, it was covered with handholds. He climbed quickly, in several strokes, and looked back down.

A dull-colored ranger 'bot drifted over, ritually intoning, "Are you injured? Answer yes or no please. Are you injured? Answer—"

Jaime snapped, "We're OK."

"—Answer yes or no please. Are you inju—"

"NO!"

"Shall I summon assistance?"

"No. Do not summon a copter. There are no injuries, and we can free the boat ourselves." He hoped. "Repeat. Do *not* summon a copter. Just go away!"

His almost sick relief that Andrea was OK was rapidly turning into hot anger. How could she be so *stupid?* Didn't she know by now that the river didn't work like space?

The ranger backed off a few meters. "You have until evening. If you cannot free your boat and continue by then, I will summon assistance." It rose into the air and took up its normal station over the rapid again, but in seconds another dull-colored 'bot drifted over. "Jaime! What happened? Did Andrea wreck the boat? I'm with *Interplanetary Inquirer* and we'll pay—"

Something snapped at that point. With a snarl Jaime leaped for the disguised snoobot, grabbing it by the camera. He smashed it to the rock and jumped onto the crippled machine, savagely grinding it into the ground. "Bastards!" he screamed. "Bastards!"

Andrea had the bad timing to have just climbed up to his vantage point. Jaime whirled to her and shouted, "And you; I thought you knew how to row a boat!" Part of his mind knew he was being unfair, but his irritation with her mistake had gotten scrambled up with his rage at the media, and he just couldn't hold it in any more.

Jaime's outburst caught Andrea by surprise, but not for long. Suddenly all the suppressed fears and frustrations of

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the last few days surged up again. She shouted back, "How many mistakes have you made on this trip, *Mister* Martinez? Plenty, that's how many, and you don't have a lifetime of reflexes to overcome. Besides, it was your stupid idea to come to a stupid planetary surface and live like stupid primitives anyway!"

"At least I didn't get the boat stuck. Now if we can't get out, they'll come pull us out. By nightfall. And we'll have to pay for it."

"That's sounding better and better," Andrea retorted.

"That's it. Bail out. Just quit. That's what you've wanted to do all along," Jaime jabbed back.

Andrea flushed and searched for a response, but found that she had none. At least not a verbal one. She stalked back toward the edge of the cliff, climbed back down to the boat, and started loosening one of the straps holding the frame to the pontoons.

"What the hell are you doing?" Jaime shouted from above.

"What does it *look* like I'm doing? I'm getting the boat out of here. It shouldn't take *your* great experience to see that we're going to have to take it apart." She turned her back to him and tugged on another strap. She felt a moment of vindication when Jaime climbed down beside her and began to help, but it was short-lived. She had no room for anything but anger.

Jaime was rowing their newly-rebuilt boat, wincing when he flexed the gash on his right arm, wincing also when he realized how badly he had screwed up. They were back in the water again, but two people in a boat do not make a marriage. Andrea sat sullenly at the bow, light-years away and receding. Her plan had worked; they had managed to free the boat by dismantling it completely, lugging the pieces below the rapid, and putting it all back together. The project had taken all afternoon, but they hadn't said a word in all that time. *Amazing*, Jaime thought wryly, *how much work you can do without speaking*. It made the ancient legend of the Tower of Babel even less credible.

The now-familiar roar of a major rapid waxed louder.

"Dubendorff Rapid ahead," the guidebot announced. "It contains many partly submerged boulders. I recom—"

"Shut *up!*" Jaime snarled. He pulled on the oars, bringing them out into the middle of the current. Lined up for the run, he waited while the roar grew louder and louder, but the boat began drifting broadside again. He pulled savagely, trying to straighten it out, in his anger forgetting that he'd had to splice the damaged oar with driftwood. The splice cracked suddenly, with a report easily audible above the rapid. He swore, still flailing the broken oar, the end flopping around on a few tendrils of graphite filament.

Andrea, seeing the situation, scrambled back for the outboard. She grabbed the handle and started to turn the boat just as it slammed broadside into the large wave at the head of the rapid. The boat tried to flip over, but before it could the motor bit into the water and shoved the back end around. They were facing straight downriver again, but Jaime, with only one good handhold, lost his perch on the rowing seat and was swept

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into the river, still clutching the end of the broken oar.

He threw the useless oar away from him, felt the water cushion around a boulder and throw him to the side, and had only a moment to take in a breath before he slid into the hole below the rock. Water closed over him, tumbled him end over end through another wave. He gritted his teeth when the life jacket's siren began to wail.

The rapid seemed to go on forever. Andrea may not have seen her life flash before her, but Jaime got the full-length feature. The director brought the whole show to focus on the last scene at Bedrock Rapid, and Jaime felt the hot flush of shame. Wouldn't it be just great if he died now? How would that make Andrea feel for the rest of her life?

Or worse, what if *she*—?

But she was waiting for him at the bottom of the rapid, using the outboard to nose the boat up beside him. He climbed out, laboriously, and waited for the siren to stop. He was trying to think of how to start an apology when he saw the expression on Andrea's face. She was grinning like a thief.

Jaime felt a surge of irritation. She was laughing at him! But as Andrea burst into helpless peals of laughter he finally started grinning, too. It was either laugh or get mad, and he had already made that mistake once.

By the time they set up camp just below Dubendorff, Jaime had worked out his apology. Andrea had seen it coming since the moment they had burst out laughing together, but she still tried to look surprised when he sat down beside her next to the fire and broached the subject.

"Andrea," he began, "I want to apologize for the way I've been acting this whole trip. I've been a jerk the whole way and I know it. You've been a saint to put up with me for so long, and if you decide you don't want to anymore I'll understand. I just hope you'll give me another chance. I'm not making any excuses, but I want you to know that I was scared for you back there, and then when you were OK . . . well, it just spilled out wrong. And with that damned snoobot hassling me; I guess I got a little crazy. I didn't mean what I said. You've really done very well. I'm sorry." He took a deep breath, then said, "I guess I was also feeling guilty for getting you into this. I was hoping for a wonderful, romantic experience, something we could remember all our lives. I really wasn't planning on a . . . a survivalist marathon."

Andrea said nothing for a minute. She'd been working on an apology of her own, but after Jaime's what she'd planned to say wouldn't have worked out right at all. "You know," she said at last, "there at Bedrock I really was wondering whether I'd made a mistake. I thought I was ready to leave, right then, you and the river and this . . . this—" she almost said "Godforsaken," but thought better of it "—this overwhelming planet. I really thought I was. But then when you went in the water—" she almost said "again," but thought better of *that*, too "—when you went in the water back there I was terrified. I was thinking if you drowned it would be my fault, because I'd broken

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the oar, and I . . . and . . .I . . .'' She shook her head. ''I was so relieved when I saw you were OK; it caught me by surprise. And then *you* looked so worried, I couldn't help laughing. And then I thought, well, maybe I wouldn't leave. At least not yet.''

He nodded, avoiding her eyes. ''Your way of showing relief is better than mine. I'm sorry, Andrea,'' he said again.

''Apology accepted. But Jaime, for Lord's sake, please be patient with me. I've got lots to learn, and I *will* learn it, but give me some time.''

''*We've* got lots to learn,'' he corrected. ''I'll give you all the time you need, if you'll do the same for me.'' He took her hands in his, looking intently into her eyes now.

She gave him a long, intense kiss that answered his question nicely. When they came up for air, the look in her eyes was unmistakable. Once again, Jaime reached up to begin the removing of clothes.

''There *are* many things to learn,'' the guidebot said suddenly. ''I don't know how I've managed to get so deep into the canyon without giving you the whole story of Major John Wesley Powell, who first ran the Colorado River in the summer of 1869. His popular journal of the river trip, entitled simply, ''Down the Colorado,'' details many of his heroic actions, but few people realize that Powell was an American Civil War hero before he took on the river, losing his right arm in the famous Battle of Shiloh. That did not deter him from undertaking what had to be the riskiest—''

Jaime reached down, picked up a rock, and with one continuous motion threw it toward the boat. They heard a satisfying crash, and the guidebot's monologue stopped abruptly.

''Beta-test, huh?'' Andrea giggled.

''Not any more. It's just you and me now. You and me and the river. Now where were we? I forget.''

''Maybe we'd better just start from the beginning again.''

''You're right. I Jaime, take thee Andrea. . . .'' ■

I had looked back at the blue Earth and thought: How very beautiful our Earth is. I'd been so lucky to go to the Moon. But after all was said and done, I was also very glad to be going home.

Alan Bean
submitted by John Hradsky

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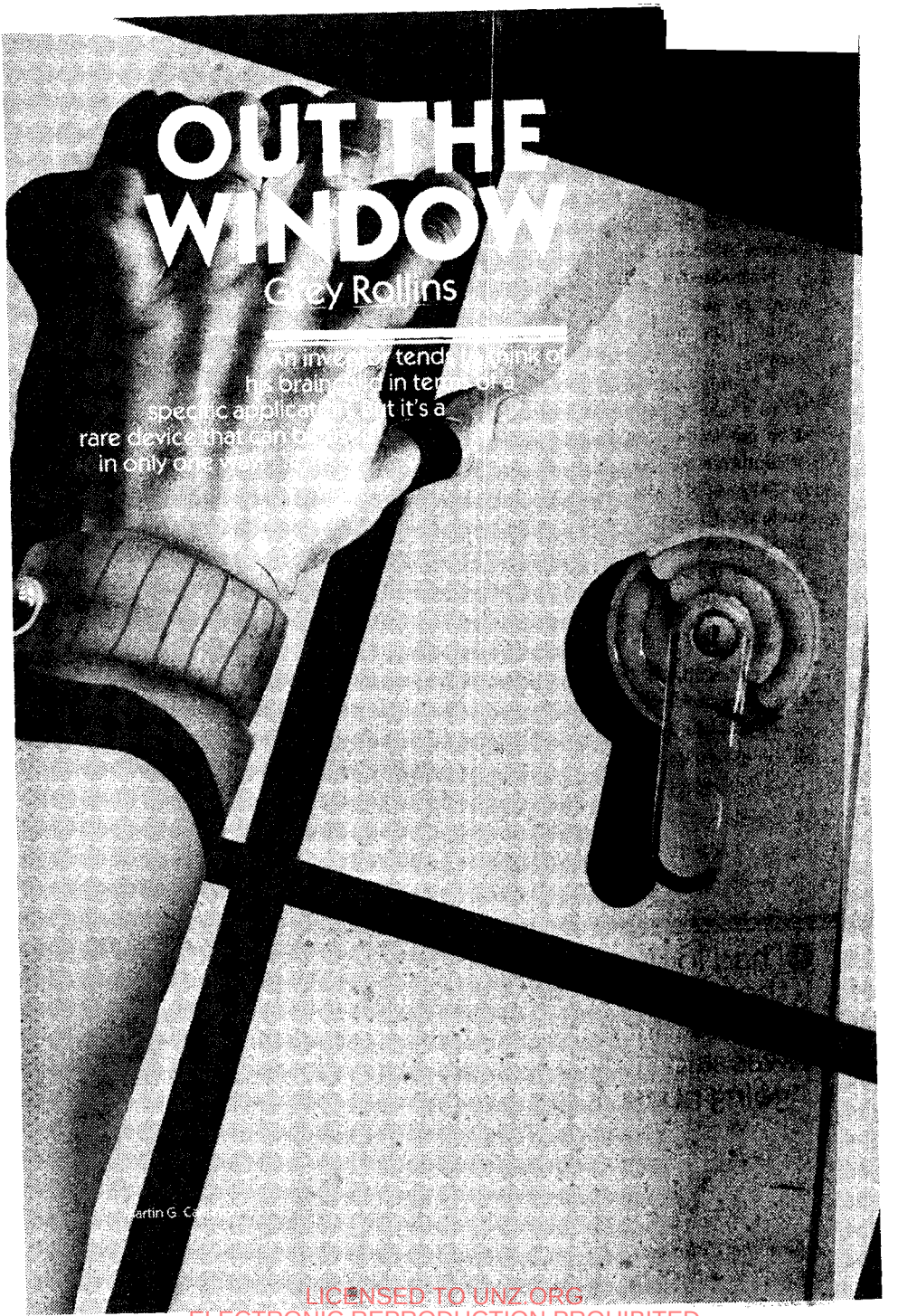
OUT THE WINDOW
Grey Rollins
An inventor tends to think of his brainchild in terms of a specific application, but it's a rare device that can be used in only one way
Martin G. Conroy

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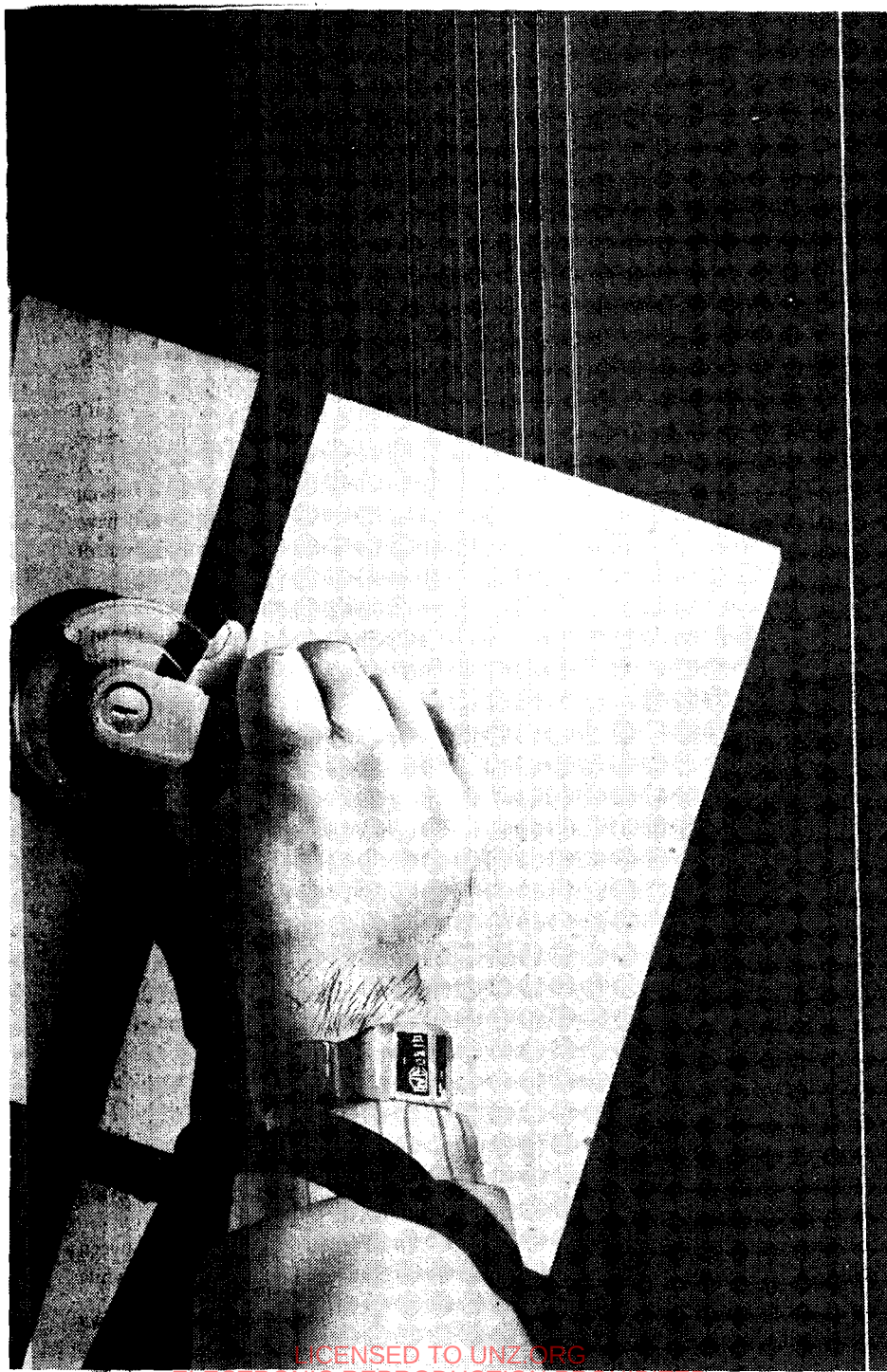

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Ask anyone. They will tell you that I don't like surprises. Finding your research partner dead in a storage closet counts as one hell of a surprise in my book.

It was a rainy Monday morning. I could hear it dripping outside the window as I stared at Robert Landon's cold body. Rigor mortis had set in and the cool temperature in the room had preserved the body. There was a slight bluish tinge to the body which I seemed to recall indicated death by asphyxiation. He had not died pleasantly.

Coming to my wits, I backed out and locked the door. I quickly made my way to Roger Merrick's office. He's the head of the department and rates a secretary. Her name is Claire Williams.

"Claire, I need to see Roger right now," I told her, leaning over her desk.

"Hank, I can't do that. He's in there with Thomas from Synthitec."

I straightened, realizing that I might be striking an overly theatrical posture looming over her like that. "Claire, I'm serious. Get him out here on some pretext and I'll take it from there, but I must talk to him immediately."

She sighed and punched a button on her intercom as she noted conversationally, "He told me that he was under no circumstances to be bothered with calls while he was in conference."

I shrugged. "We are as pawns in the hands of fate. I didn't ask for this, either."

It seemed like a long time, but Roger finally answered. "Yes, Claire?" he said frostily.

She winced, but her voice was steady. "You have a call on line two, sir." She switched off her end of the intercom before he could reply and gave me the handset to her phone. As she pushed the button to connect me to Roger, she hissed, "If he gets angry, I'm coming after you with a pitchfork!"

Roger had on his best professional voice. "Hello, this is Roger Merrick."

"Roger, this is Hank. You need to get rid of whoever you've got in there."

"Indeed?" I could just see his eyebrow raising as he said this.

"Robert Landon is dead, and I don't think that the police are going to make a good impression on your visitor." A bit brutal, I admit, but I wasn't about to take the long way around and have him hang up before I got to the nut of the problem.

"Indeed." Falling inflection. "Hmmm, that changes things, doesn't it? I'll be with you in just a minute."

I turned to hand the phone back to Claire, but froze when I saw her face.

"Robert?" she whispered.

If someone had offered me a one-way ticket to Tibet at that instant, I would have left without bothering to say goodbye. I had forgotten that they had been a heavy item the previous year and now nothing I could say would soften the blow. I took a deep breath and let it out slowly. "I'm sorry, Claire."

She turned pale and her gaze dropped to the desk. "I . . . I . . . oh, God!" she said softly.

Behind me the door into Roger's office opened and I heard his voice. "Yes, as soon as I get this little problem cleared up I'll be in touch with you," he said, ushering out a man with graying temples and a confused expression.

I tried to move so that I was between Claire and the man. Hiding Claire while

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she composed her face was the least I could do after I had callously trodden on her feelings.

Roger gave me an expressionless stare for a moment, then jerked his head towards the open door to his office. Once inside, I closed the door softly behind me and turned to face him where he leaned against his desk.

"I presume you are serious?" he said.

"Not only am I serious, but I think that he was murdered."

Roger considered for a second before twisting around and tabbing the intercom button. "Claire, give me an outside line, please."

"Yes, sir," came the faint voice back through the box.

"You told Claire?" It was closer to a statement than a question.

"She overheard me telling you." I shook my head. "I had forgotten that. . . ."

He gave me a merciless glare. "They were going to get married, you fool."

"I didn't know that." Tibet looked better by the moment.

He went around his desk and opened a drawer, pulling out a telephone directory. Reading the emergency numbers off of the inside cover, he reached for the phone.

The rest of the day was tied up with interminable questions and colored flashing lights outside my lab window. Finally, just after four o'clock, they packed up their cameras, fingerprint kits, and walkie talkies, and left. I was left sitting on a wooden lab stool towards the back of the room. I was only a source of information to them and they had squeezed me dry. Now I felt empty and emotionally drained. My partner was gone, probably murdered, and all I could think was that I needed to eat, whether I wanted to or not.

Footsteps approached the door tentatively. "Hank?"

I took a deep breath and straightened my back. That was Claire's voice and I would be dragged through hot coals before I did less than my best for her. Stepping down off of the stool, I skirted the long, black-topped tables until I could see the door. "Yes, Claire?"

She had on her raincoat and was holding a small purse. "I just came by to see if you were OK," she said quietly.

That cut me. I had hurt her and yet she was coming to check on how I felt. "Actually, I was concerned about you. I hate myself for not thinking about you and Robert."

"We were going to get married, but he broke it off. I never understood why . . . now I'll never. . . ." Tears started rolling down her cheeks.

"Let's leave. There's no reason to stay here." I glanced automatically around the room to be sure that everything was turned off, fumbled in my pocket for my keys, and locked the door.

We walked down the hall, our footsteps seeming to echo twice as loudly as they normally did. I stopped at my office to get my raincoat before leading her out the back door of the building. Standing under the concrete awning, we watched the rain fall into the silver and black puddles on the asphalt of the parking lot.

Claire turned to me. "Hank, I know that I need to eat, but I just can't seem to muster the interest. Will you at least

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come sit with me while I poke at some food?''

''I'd be glad to. What kind of food do you feel most like poking?''

This brought a brave attempt at a smile. ''Nothing fancy, just as long as it's somewhere quiet.''

''Wait here while I get my car, OK?'' I walked out into the rain with that kind of fast walk that people use, thinking that they can somehow slip between the drops if they move quickly enough.

Claire slammed into the seat when I stopped next to the awning. ''God, I should have walked to the car with you!''

''Why, what's wrong?''

''If Robert was murdered, then the murderer probably works here. All of a sudden I got this creepy feeling that they were going to come out of the door behind me. It was just like when you're a child and you're afraid to get out of bed because there's a monster underneath waiting to grab you by the ankle.''

Claire said nothing during the ride to a small Italian restaurant across town. I respected her silence, half afraid that I would say something wrong if I opened my mouth.

After reaching the restaurant, we made small talk for a while, avoiding by common consent the events of the day. We ate slowly, more from a sense of duty than from actual hunger. Realizing that I had been chasing the same bite around my plate for at least a minute, I glanced up to find Claire watching me with a strange expression in her eyes. I put my fork down and said the first thing that came to mind, which is how I usually get myself in trouble. ''I'm glad that there is still one woman in the world who wears her hair long. I think it's beautiful.''

So help me, she blushed. Looking down at her elbow-length tresses, she said, ''I've worn my hair long since I was little. I don't think I would know what to do with it if it were short.'' A faint smile appeared on her face. ''Perhaps if you would tell me about what you do, my mind would not go in crazy little circles.''

''I never thought of chemistry as being polite dinner conversation.''

''Well, if I asked for it then I can hardly blame you if I don't like the topic, can I?''

I shrugged. ''What the lady wants, she gets. You knew that Mark Simpson was working on a new adhesive compound about this time last year?''

''Vaguely, yes.''

''Well, it was a failure as an adhesive, but before he dropped it he accidentally discovered that it had some odd properties. He made up a batch and tried it out as tape, using it to hold some paper. It seems that the ink under the tape smeared and in the process of investigating that he found that he had serendipitously discovered a molecular sieve.''

''I assume that you mean something that will pass only certain molecules?'' she asked.

''Exactly. It's a kind of filter that can be made to pass only molecules less than a certain size. It's really quite a fascinating compound.''

''But he isn't working on it any more?''

''No, he knew he had something, but it wasn't any good as an adhesive so he turned it over to me on the condition

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that he be given credit for the discovery of the stuff. I was only too happy to agree—it has amazing potential. I have to admit to a certain respect for the man, because most people would have hidden the formula and destroyed their lab notes rather than let something go that could be as useful as this."

"Want to know something interesting?"

"Sure."

"He handed in his notice last Wednesday."

"Where's he going?" I inquired.

"The adhesives division of 3M, as fate would have it. They seem to think he's good."

"He's very good," I acknowledged.

"Go ahead, I just thought I would throw that in."

I shrugged. "Actually, there isn't a whole lot more to tell. I worked on it for a bit and found that it was temperature dependent, which limits its usefulness considerably, since it would have to be used in a controlled environment. After a while I went to Roger and asked him if he could spare someone to help me work on some of the variants of the basic compound. He gave me Robert last spring." I checked her plate and found that she had eaten a small amount of her dinner. "How am I doing so far?"

She looked down. "Fair to middlin'. I'd say that you're on the right track, anyway. At this rate I might finish by midnight."

I laughed quietly. "Well, I guess I'll keep babbling if you can stand it."

"Tell me what happened to Robert."

I studied her carefully. "That is definitely not polite dinner conversation, Claire."

"I'm asking. Sooner or later I'm going to want to know."

"No."

"Just give me the basics. Use your own judgment as to what is appropriate to tell me," she said.

Sighing, I told her, "It was almost certainly murder. He died of asphyxiation in the storage closet."

"Are those closets that tight?" she asked.

"Almost. The doors are gasketed against the possibility of an explosion in the lab. You wouldn't want the concussion to break a bottle of something nasty like nitric acid and have that to deal with as well as the aftermath of the explosion. It's a comparatively cheap form of insurance."

"Isn't there a window?"

"Yes, but it's gasketed too. That's to keep out humidity on wet days like today. There's also a steel grate on the inside to keep someone from breaking in and stealing the chemicals, some of which are fairly expensive, like the platinum we sometimes use to catalyze reactions." I stopped and forced myself to take a bite off of my plate.

"Why couldn't he just open the door and come out?" she asked quite reasonably.

My tongue stuck to the roof of my mouth. There was no way I could tell her about his shredded, bloodied fingers where he had clawed at the door and window, trying to escape until he collapsed from lack of oxygen. "Uh . . . well, the door was locked."

I thought I had gone too far even in telling her this, for she stopped chewing

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and sat back in her seat with eyes closed. She swallowed heavily. "Hank, you're not telling me something, right?"

"Right."

She nodded slowly, eyes still closed. "OK. I won't ask. Ever."

"Do you want me to stop?" I asked.

"No . . . not yet. I'll tell you when I've had enough. Is there not a lock on the inside of the door?"

"No, not in the older labs. The part of the building that I work in was built in 1954. Back in those days they weren't into trying to keep people from getting locked into storage rooms. They never dreamed that it would happen on purpose."

Her eyes opened and she spoke. "So that's why Roger had me call the locksmith. I couldn't figure it out at the time, but he wanted locks that would open from both sides."

"Chances are that we were in violation of some safety ordinance. I'm glad I'm not in Roger's shoes right now, because they will come down hard on him if that's the case."

"Bad pun, Hank."

"Huh?" I was confused.

"Case . . . locks . . . " she supplied.

"Oh, sorry. It wasn't intentional, I assure you." I gave her a wicked grin. "Case as in police, too."

She smiled an honest smile. A for real one that actually looked like she meant it. "Maybe I had the right idea corralling you into taking me out to dinner, Hank."

"I'm glad you think so. Have you had enough?"

"Not quite yet."

"The cops are confused about one aspect of the . . . case. There seem to be signs that the body was exposed to some fairly intense cold before he died."

"What kind of signs?" she asked as she forked up her last bite.

"Frostbite."

"Frostbite? It hasn't been that cold!"

"I know that, you know that, and the police know that, but Robert's toes and fingers were frostbitten. I told you that they didn't understand it. There isn't any heat delivered directly to the storage room, but enough conducts through the door and walls from the lab to keep it well above freezing in there."

"That's weird. I don't follow that at all." She thought for a moment. "Could he have been killed somewhere else and left in the storge room after he was already dead?"

I thought of the bloody smears on the door and by the window. Robert had been alive when he had made those. "No."

"Uh, OK. You say that with the kind of tone that means quit asking questions," she said.

"I'm afraid so, Claire," I told her.

"OK, let me get this straight. Robert died of asphyxiation sometime during the weekend in a storage closet off of the lab the two of you share. He was locked in by someone standing out in the lab. Someone who had a key." She stopped and gave me a speculative look. "You have a key to that closet. . . . "

I thought back through all the questions that the police had hammered me with during the course of the day, based on just that premise. "There's no way I can prove that I'm innocent, Claire. All it would take would be an instant at the end of Friday afternoon—just to

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lock the door and walk away. But, no, I didn't do it. It turns out that there are four keys to that door. Obviously, I have one. Robert had one. Roger has one. The fourth one was kept in a drawer at the end of the workbench nearest the door. A lot of people knew it was there, in case we forget and leave our keys at home."

"And that key is gone?"

"No, as a matter of fact, it's still there. The police checked it for fingerprints, but it was clean, which tells them right away that it was the one used, because it should have had somebody's fingerprints on it—that key does get used occasionally."

"That still doesn't get you off the hook. You could have used that one as easily as your own."

"I know," I admitted. "If you don't feel comfortable about being out with me, we can send for a cab to take you home and I'll stay here. You can verify that once you get home by calling back here and asking to speak to me. It's not foolproof, but it's the best I can do offhand."

She shook her head. "That still wouldn't prevent you from leaving straight from here and coming out to my house. My name is in plain print in the phone book, complete with address."

"OK, I'll do whatever you suggest. I will point out that the police have already gone over me with a fine-tooth comb."

"Oh, don't worry about it, I don't actually think that you did it or I would have told you that I was going to the powder room and simply vanished without bothering to tell you that I was leaving or where I was going . . . which certainly wouldn't be home."

"I bow to superior logic," I told her.

"Logic, my foot. It's feminine intuition. You just don't feel like a murderer," she said.

"Thanks, I guess," I replied. My plate was only half empty, but I wasn't interested in eating any more. I looked at Claire. "Ready to go?"

She, too, glanced at my plate. "You're not going to finish that?"

I shook my head. "No, I think they'll have to send it to the starving children in Africa or wherever."

"In that case, I guess I'm ready."

I paid the bill and we walked out into the damp, cold night air. Claire held out a hand and watched the raindrops splat into her palm by the light of the restaurant's neon sign.

"Somehow, this rain suits my mood. It's good weather to be sad by," she said.

"I won't argue that. I only knew Robert through work, but it will be strange not to have him around." I glanced at her. "Want me to drive you home, or did you want to phone for that taxi I was talking about?"

"As it happens, I need you to take me back by work so I can pick up my car."

"Can do."

We drove back through the night, watching the stoplights blur through the rain on the windshield. As I pulled back into the parking lot, I asked her, "Where is your car parked?"

"Over next to Roger's parking spot. What's wrong?"

I had stopped the car and was staring at the building. The lights were on in

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my office. "Oh, nothing. I must have forgotten to turn off the lights in my office when we left." I drove on around the building to where she had indicated that her car was parked.

"You're worried about the lights being on in your office, aren't you?" she asked.

"No, I'm almost sure I left them on by mistake. I'm just letting this thing about Robert spook me for no reason." I made no mention of the fact that I was certain that I had turned them off. I remembered doing it with my left hand while clutching my raincoat in my right.

"Are you sure?"

"Yeah, I'll go inside and turn them off before I leave."

"Well, OK. Listen, I appreciate your going to the trouble to take me out to dinner. I know I wasn't very good company, but I really didn't feel like being alone just yet."

I smiled at her. "Any time, Claire. I just hope I didn't bore you rattling on the way I did."

She surprised me by leaning over and giving me a quick, soft kiss. "Good night." She got out.

I waited until I saw her car lights come on and the reverse lights flare before I started back around the building, watching her tail lights going the other way in my rear view mirror.

When I got to where I could see my office window again, the lights were off. A light three windows further down was on, however. If I was right, the window that was lit was the one in Robert's office. Trying to ignore the acid chill of fear in my stomach, I turned out my headlights and coasted to a stop near the back door. Switching off the ignition, I eased out of the car and gently closed the door behind me.

I slipped through the unlocked outside door. The rain dripping off of my raincoat made a tapping on the linoleum floor that sounded as if I were dropping pebbles as it echoed down the dim, empty hall. Swearing under my breath, I slid my raincoat off and dropped it on the floor. Water began to pool around it instantly, but at least it was doing so quietly.

I stepped carefully down the hall toward Robert's office, trying not to let my wet soles squeak against the floor. As I passed, I looked at the space under the door to my office.

Dark.

Three more doors, two doors . . . the light was off in Robert's office. I reached out and tried the door gently.

Locked.

I stood and thought in the darkened hallway, desperately wishing that my heart would not beat so loudly. If someone was showing a surreptitious midnight interest in my office and Robert's, the only other logical place for them to go was the lab.

Trying once more to creep quietly, listening for every slightest sound, I turned the corner to the hallway where the lab was. I could see light faintly through the frosted glass window set in the door. It was about the right amount for what would come through the outside windows from the parking lot, but I took no chances.

I tried the knob with a feather touch. It did not turn. I took out my key and opened the door as quietly as I could. Standing there in the darkness, I tried to hear whether there was anyone in the

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room. Nothing reached my ears but the sound of my own breath. A locomotive in full cry could not have sounded louder to me at that moment.

Gathering my courage, I reached over and cupped my hand under all four of the light switches and snapped them all on at once.

The room was empty.

Turning, I closed the door behind me. Still trying to walk silently, I went over and sat on the same stool that I had occupied that afternoon.

I thought furiously, trying to conjure some excuse that would account for the lights turning on and off. Perhaps it was the custodial crew cleaning out the offices. It would have been pure coincidence that they were in my office when I happened to see the lights on. Then they could have worked their way down the hall, cleaning the intervening offices while I was around the front of the building dropping off Claire at her car. By the time I got back around to the other side of the building, they would have made it to Robert's office, emptying trash cans and ash trays as they went.

Then where were they now?

They should have been, at most, two or three offices farther down the hall. I should have had no trouble hearing them. I had been in late enough before that I had heard them coming down the hall around nine or so. They made enough racket to wake the dead. Once they came in, the building belonged to them and they knew it.

I looked at my watch. It was eleven thirty. They were already gone for the evening. It had not been the custodial crew.

I stood and walked over to the storage closet. Whatever had killed Robert Landon was in that small room. I took out my key and unlocked the door. Steeling my nerves, I swung it open and turned on the light.

The room was the size of an average kitchen, with gray metal shelves lining the walls and projecting in rows out into the middle of the floor. Tidy, organized bottles, boxes, and spare glassware filled the shelves to capacity.

On the floor was a colorless chalk outline of where Robert had fallen. That spooked me. It was almost as bad as if his body were still there.

I tried to look without looking, but the blood was still on the wall—brown smears. The custodial crew had probably been told not to touch it, I decided. If told there was a delicate experiment going on in here that was not to be disturbed, they would not know the difference, nor would they care. What's one more experiment in a building full of people doing strange and often smelly things?

At this thought I took a breath, testing the air with a chemist's nose. Nothing to speak of, a slight earthy smell which could be due to the dried blood . . . or just as easily not. There had been enough people in and out of this room during the day that the air had probably been exchanged ten times as often as during a normal work day.

Something about this room had killed Robert, yet nothing seemed abnormal. Looking once more over my shoulder into the lab, I started to go over the room methodically. The police would have done this painstakingly earlier, but they might have missed something. The whole room would seem strange to

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them, whereas I was familiar with it. Thinking in this way, I could not see why they had not asked me to look over the room earlier. Probably thought that I, as an amateur sleuth, would have them chasing red herrings every time that I saw a bottle that wasn't where I thought it ought to be.

The funny thing was that it took less than a minute to find it.

A label laying face down, torn from a reagent bottle to expose the white, uncolored paper on the back. It was on the metal shelf to the right of the door at shoulder level. Robert had left me a message that I had been too overwhelmed to stop and look for that morning.

It was easy to see why the police had ignored it. There was no visible writing on it and the bottle that it had been ripped from was standing right behind it. They probably had concluded that it had been pulled off accidentally and had gone on to examine other things. They did not know that both Robert and I insisted on a perfectly organized storage closet where we could find anything at a moment's notice. Ripped labels were not part of our way of doing things.

I held the paper up to the light, first one way, then another. Then I held it up edgeways, so the light came across it at an angle.

Crude letters had been pressed into the paper, probably with his fingernail. It was a standing joke that Robert could never find a pen when he wanted one and this one last time he had been unable to go back to his office to get another.

It was difficult to read because he had not succeeded in making a very deep indentation. Possibly he had been trying to write against the hard metal shelf itself.

It looked as though there were two words, maybe three. One on top and either one or two below it. The top word was not too difficult to make out. It said Maxwell. I stopped and thought. No one named Maxwell, either first name or last, worked with us. The first letter on the second line was a D, followed by what might be a lower case e. The rest was illegible. It was frustrating, because he would not have gone to the trouble to make this note unless he thought that it was important. If he had known the name of his killer, he would surely have put it down as well. Maxwell, however, was not anyone that I knew.

My sixth sense went off too late.

I felt the air move as the door behind me slammed shut with a force sufficient to shake the wall. Then came the unmistakable sound of a key turning in the lock.

With nothing to lose, I shouted. "Hey! Unlock this door!" I kicked the door with all my strength.

"Sorry, Hank, I can't do that."

The voice was muffled, but I thought I recognized it. "Mark? Mark Simpson! Why are you doing this?"

"Why do you think, Hank?"

"The molecular sieve? If you wanted it, then why did you hand it over to me?"

"I didn't see quite where it would lead. A thin film filter is nice, but it's not something that the world is panting after. Before the night is out you'll see that Robert found something fascinating."

"And whatever it is, he told you."

"I stopped in to tell him good-bye on

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Friday afternoon. He had just figured out the secret of the sieve. He had set up the storage closet as a test chamber. . . . crude, but effective. The answer was right in front of all of us the whole time, but we didn't see it. All I dropped in for tonight was to get copies of your lab notes. Good-bye, Hank."

I shouted until I was hoarse, but he did not answer. Shortly I heard the door to the lab close, and, a minute later, a car started and faded into the distance.

I wasted time cursing myself for turning my back on the door, then sat down on the floor and began to think. Obviously, from what Mark had said, there was a sieve in the room. The logical place for a sieve was in the window, but, try as I might, I could not tell from where I was whether any of the panes in the window had the odd, pinkish tint of the sieve compound.

Assume that one or more of the panes in the window is made out of the sieve compound. OK, so what?

So it killed Robert, that's what.

But how can the sieve kill someone?

I sat down and tried to reason it out. The sieve compound had started life as an adhesive. The effect that Mark had discovered was based on the fact that the molecules formed a hexagonal crystalline lattice if they were allowed to cool slowly enough. This hexagonal structure was open clear through, like a tunnel. The size was of the right scale to pass complete molecules and could be changed with slight variations in the formula.

The problem was that the compound had an unforgivable amount of elastic give, right down to the molecular level. This had been the drawback right from the first. Any time that it was being used as a barrier to filter a gas, the larger, higher energy molecules, which would normally be kept from passing, would tear right through the lattice. This led to the discovery of the really obscene thing about the sieve compound. The crystalline structure was self-healing.

In a crystal made from any rational compound, if you caused a break in the crystalline structure it was broken and that was that. You might as well wish that a broken glass would mend itself. But in the sieve compound, owing to its background as an adhesive, molecular-sized breaks welded themselves back together as though nothing had ever happened. It was maddening.

The best theory that we had at the moment was that, for reasons as yet unknown, one bond of the hexagon was looser than the others, with the tighter ones acting as "hinges" to the loose one. When another molecule hit with enough kinetic energy, in other words if it were hot, it would tear through a succession of these hexagons, popping the loose bonds like a fat man bursting buttons off of his vest. Then after the hot molecule had passed, the sides would snap back into their original places by pivoting around the "hinged" ends.

I rubbed my arms to try to keep warm. I had never noticed that it got so chilly in the storage closet at night.

Something was bothering me, but I was unable to put my finger on it. Shrugging, I stood and stared at the window. The window was set rather high in the wall, but not so high that I could not reach it if I tried. The problem was that I had no screwdriver to remove

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the grate in order to break out the panes. As a matter of fact, I didn't have anything that Robert didn't have with him. . . .

I did have a pen. I got the piece of paper that Robert had scratched his last message on and wrote MURDERER WAS MARK SIMPSON off to one side where it would not obliterate Robert's letters.

Honestly, I did not see what I had to worry about. I would end up spending an admittedly uncomfortable night in the storage closet, but in the morning it should not be too difficult to get someone's attention, tell them to get the spare key out of the end drawer and let me out.

I would then call the police and . . .

At this point I noticed my breath fogging.

It was getting too cold for comfort. I put my right hand under my left armpit and held Robert's note in my free hand.

Maxwell. With the faintest suggestion of another squiggly letter after the second l. Could it be a crooked s?

Maxwells. That didn't help any. I didn't see why he would write Maxwell or Maxwells when neither resembled Mark Simpson's first or last name. Could he have been delirious when he wrote it?

Giving up, I put the note back on the shelf and did several deep knee bends to try to warm up. After the eleventh one I nearly blacked out. Dizzy, I slumped against the rack of shelves.

Robert hadn't died of the cold, he had died of asphyxiation! I was going to run out of oxygen before I froze to death. Where was all the oxygen going?

Out the window, of course. Robert had made up a batch that filtered oxygen. No, that wasn't right. If it let oxygen out, then oxygen could get in. The holes were the same size from either side. So where the hell was my oxygen going?

I slid to the floor, then reached up and grasped Robert's note once more. He had been trying to tell me something, but I wasn't smart enough to get the message.

Try though I might, I could not make my brain come up to speed. Maxwells, indeed. The bastard had probably been out of his skull when he scratched the note. In irritation, I threw the note on the floor and stood. I had to at least make an attempt to get out of this trap, if only to save my self respect. No man is an island. . . . no that's not what I meant to think. Damn, I need air now.

Studying the door, I noted the standard, metal-sheathed door often found at schools and industrial sites around the world. Looks like they did a smooth job of putting that baby in. Edges fit tight. Almost like it grew there. How long would it take to grow a door. . . .

Shaking myself to try to break free of the growing woolliness in my mind, I turned to the window. The door was out of the question—no way to get through the metal. Maybe there was some way I could break out the window. I picked up the nearest thing at hand, which happened to be the bottle that Robert had ripped the label off of to write his last message on. Message in a bottle . . . no, it was a message on a bottle . . . well, actually, it was a message on the bottle's label.

Inside my head, a voice screamed not to throw that bottle. Something was ter-

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ribly wrong, but I could not figure it out. It was a lot of trouble to think just now.

I stared at the bottle. Clear, heavy glass. Yellow plastic top. Big deal. Lotsa stuff comes in glass bottles.

Don't throw that bottle, said the little voice in the back of my head.

Shut up. It's my bottle and I can throw it if I want to.

Read the label, said the nagging voice that didn't want me to throw my bottle.

I looked stupidly at the remnants of the label. Not much left. Some dumb reminder about always add acid. Any high school kid knows that. I almost threw the bottle, but something caught my eye. It was the paper that Robert and I had been writing on. It had floated down on the floor with the colored side up when I had thrown it earlier.

One word punched through to my increasingly sluggish brain. Sulphuric. I moved the foot that was covering the rest of the label. My foot.

The next word was Acid. Even though the rest of the label was in smaller print that I could not read from my standing position, I knew it by heart. Bunches of terms like Reagent and stuff like that. Neat, important sounding words.

I looked at my bottle with pride. I had a bottle of Sulphuric Acid here. Let's see . . . two hydrogen atoms and a sulphur atom . . . Sulphur. Yellow stuff. Smells awful when it burns. Brimstone. Demons with pitchforks and barbed tails. Demons . . . demons . . . something about that word.

My brain went into overdrive.

The note had said Maxwells De. Maxwell's Demon. The sieve in the window was letting out all the hot molecules of oxygen as I exhaled. The human body doesn't burn all the oxygen molecules that it takes in, but it does heat them up. Exhale, and the newly heated oxygen molecules go zinging out through the sieve. Maxwell's Demon was a molecular sieve that let fast, hot molecules pass, but not slower, cooler ones. Being chilly outside, very few oxygen molecules had the energy to punch their way back in.

Robert had discovered a cheap way to air condition a room. No power required. All that was necessary was to make a way for cool molecules to come in and replace the hot ones that were leaving. Cheap air conditioning would be worth a fortune indeed, if handled properly. Just needed some more work. Maybe cheap heating—that would be even better.

I looked up at the naked light bulb in the ceiling. Even it had been contributing heat to make my precious oxygen go away. Robert had been smarter. He had turned the light off to keep his oxygen cooler so that it would not zip out through the window quite as quickly.

I looked at the bottle of sulphuric acid in my hand, then at the window. Then I threw it with all the strength I could muster. In doing so, I lost my balance and fell.

When I opened my eyes, I saw Claire's beautiful, blonde hair, but could not focus because my eyes burned and teared. I croaked out for water; my throat was on fire. She whirled around and faced me and I saw that she had been crying. She removed an oxygen mask from my face and held up a paper cup full of water. I drank a bit, but it hurt to swallow. The water tasted foul.

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I squinted and saw that I was in the hallway outside the lab. People in white were all around me, as well as people in blue. White uniforms were paramedics, blue were police. I looked back at Claire. "Did I tell you that you have beautiful hair?"

She bent over and kissed me on the forehead gently. "You told me. Now take it easy, your leg is hurt and they say that you may have trouble breathing."

"What's wrong with my throat?" I whispered.

"You broke a bottle of sulphuric acid in there. The fumes . . . "

I nodded. "I remember now." The little voice in the back of my head had been years of healthy paranoia about breaking bottles of concentrated acid. That meant that the brackish water that Claire was giving me was probably a baking soda solution to neutralize the acidity in my throat. The oxygen was to help take part of the load off of my abused lungs.

"Simpson," I croaked.

"Shhh," she said. "Everything is going to be all right."

"Simpson!" I insisted.

Her brow furrowed. "What about him?"

"Killed Robert. Nearly killed me."

That got their attention. One of the white uniforms moved and a blue one took its place. "The young lady tells me that you're saying a man named Simpson killed Robert Landon?"

I nodded. "Mark Simpson. Killed Robert. Tried to kill me." It hurt to talk.

He pulled a small microphone clipped to a loop on his shoulder over towards his mouth and began to speak gibberish very quickly. I leaned back into what turned out to be Claire's lap and looked up at her.

"How did you get here?"

"I was worried about your going back into the building, so when I got home I tried to call you. I couldn't get an answer at your home or at your office, so I came back. As soon as I saw your car parked at the back door I knew you were in trouble, so I called the police from the gas station across the road, then came in after you. The rest was easy. Mark had put the key back in the end drawer just where you had said it was kept."

One of the white figures spoke up. "She probably saved your leg by doing that. The sulphuric acid had splashed and run across the floor and was just getting to your leg when she got the door open. You'll have a scar on the back of your calf, but if she had waited five more minutes you would have lost the use of that foot for life."

"It smelled awful in there, Hank, why did you do that?" Claire asked.

"Is one of the panes gone out of the window?" I whispered.

"Yeah, there are two panes that look like they burned," said the policeman. "What happened to them?"

"They were made out of an organic compound. Sulphuric acid tears organic molecules apart. It was the only way I could get air."

"Damned risky thing to do. They tell me that the fumes from that stuff will rip your lungs out. We couldn't figure that part out at all," he said.

"Didn't you see the note?" I asked.

"What note?" he asked.

"Paper note . . . never mind, it was

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on the floor and the acid probably got it."

Claire pushed the oxygen mask against my face again. "Shhh, quit talking."

The paramedic smiled at me. "This young lady was pretty brave to go in there after you. The fumes must have just about knocked her out."

"I just held my breath," Claire said. "Nothing to it."

"Yeah, and the fumes didn't burn your eyes, either, I'll bet."

That was why she had been crying—the fumes had hurt her eyes. "It was nothing, really," she insisted.

"Nothing!" he snorted. "I've seen grown men who couldn't do what you did. You're pretty surprising."

"She's a surprise that I could grow to like," I mumbled through the oxygen mask, but neither of them heard me and wouldn't have understood if they had. But I understood and that's what counted. ■

FUTURES

(continued from page 85)

is the only one that can allow it to be refilled.

But I risk giving away too much. Unlike most genre films that mistake shock—more blood, more chestbursters, more weirdness—for surprise, *The Seventh Sign* is filled with plot twists that grow ever more clever, ever more emotional. Plot conventions are played with. For those of us who grew up with the benevolent priests of *The Exorcist,* this film delivers a wonderful corrective, a priestly image that is spell-binding in the dimension of its evil nature. A spooky stranger may be the only one you can trust.

Perhaps nothing about the film is more heroic than its casting of a man with Down's Syndrome in a key role as a murderer on death row. Accused of killing his parents, he refuses to plead insanity, and he is doomed to be executed in the gas chamber.

His situation is hopeless. Completely and totally.

Unless hope can be reborn.

When the film ended—and, mind me I'm generally one jaded viewer—I sat with a dear friend, both of us fighting tears, moved like we haven't been by a film in a long, long time.

Moved, by a horror movie. . . .

I went to Brooklyn Prep, a now-defunct Jesuit high school. And, it turned out, so did William Peter Blaaty, the author of *The Exorcist* and the father of most of us who toil in the fictional supernatural vineyard. And whatever our respective current views of religion may be, we obviously took away some idea of a grand scheme, the really big themes of good versus evil.

Not the mindless, numbing vulgarity of some ax-wielding zombie who just can't say no to lopping off the heads of pretty coeds. A supernatural book or film can leave us terrified, but also excited by our contact with something mysterious and overwhelming. As R. Crumb's cartoony Mr. Natural would say, "It's Cosmic!"

Or it can be. What we get, usually, though, is a steady diet of gruesome junk. But for some hope—for films, for the genre—and a wonderful film experience, *The Seventh Sign* is an important release. ■

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the reference library

By Tom Easton

Imago, Octavia E. Butler, Questar, $19.95, 272 pp.
Rimrunners, C.J. Cherryh, Questar, $19.95, 336 pp.
Men Like Rats, Rob Chilson, Questar, $3.95, ? pp.
The God Box, Barry Longyear, Signet, $3.50, 235 pp.
The Drawing of the Three, Stephen King, Plume (NAL), $12.95, 400 pp.
Still Forms on Foxfield, Joan Slonczewski, Avon, $2.95, 214 pp.
Things Invisible to See, Nancy Willard, Bantam, $3.95, 262 pp.
Moon Mirror, Andre Norton, TOR, $17.95, 336 pp.
Pulphouse 2, Winter 1988, Kristine Kathryn Rusch, ed., Pulphouse Publishing (Box 1227, Eugene, OR 97440), $17.95, 243 + x pp.

It is a cliché that you can't change other people. You may be able to produce apparent change, but it will be imperfectly accepted, superficial, temporary. The only deep and lasting change comes when the changee changes himself or herself.

Octavia E. Butler must know this cliché well, for she is busily demonstrating it in her marvelous "Xenogenesis" series. Here's the background: Humans have destroyed their world and their species in nuclear war, but the alien Oankali, masters of biological technology, driven by the quest for genetic novelty, compelled to hybridize with other sentients, have snatched a few survivors and put them on ice while they help Earth recover. The series began when the Oankali thawed out the first humans and told them what the new deal was. Henceforth, all reproduction is in teams of five—male and female human, male and female Oankali, and the Oankali third sex, the neuter ooloi, who combines the disparate gametes of the other four to create the hybrids; if you don't like, we'll sterilize you and turn

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you loose; the Earth is ours now. The second book introduced the idea that humans had a right to a future, even though they had forfeited the future once already. Thanks to the efforts of a tragic hybrid child, cut off from family and potential mates, the sterilized humans or resisters were offered the chance to colonize Mars and thus a chance to prove that the combination of hierarchy and intelligence in their genes need not inevitably be fatal.

Imago is the third book. It features Jodahs, the first ooloi to emerge from the human-Oankali hybridization. It is suspect, for many believe that humans are too flawed for successful hybridization (those who believe this most strongly have held themselves aloof from the gene-mixing). But as it metamorphoses from child to subadult (or imago) to adult and begins to learn and exercise its abilities, it shows everyone that here, finally, is the deal the humans cannot refuse. It is a *human* gene-mixer, and even the most extreme resisters are willing to mate with it—even though it has the extra arms, tentacles, and other features of the Oankali.

That is, a people's changers or leaders must be drawn from among themselves. Martin Luther King had to be black. Mao had to be Chinese. Castro had to be Cuban. All the foreigner, the alien, can do is to help establish the conditions for change, to help King or Mao or Castro to appear. With that done, the aliens can leave while the locals work out the implications of change for themselves.

Will that be Butler's next book? Will the Oankali leave, or at least move offstage, while the hybrids begin to shape the terms of the gene-exchange in new ways? Prepare yourself to find out by grabbing this volume as soon as you can find a copy. You'll enjoy it.

* * *

C.J. Cherryh deals with the more elemental theme of loyalty in **Rimrunners,** one more stitch in her future-history tapestry of *Downbelow Station, Cyteen,* and many more. The Union-Alliance war's refugees were shunted into such odd corners as the primitive stations of the Hinder Stars. One such station is Thule, drab, run-down, untrafficked. Here is Bet Yeager, once a soldier of the Company Fleet whose remnants are now pirates preying on all and sundry. She calls herself a machinist and is waiting for a ship to dock, one that needs her. In the meantime, she is penniless prey for men of nasty inclinations.

A ship docks. The *Loki*, mean and lean, an obvious conversion job, a spook, a spy. It takes her, though it must first rescue her from station cops trying to account for a couple of bodies. In it, she finds a young man, Ramey, traumatized by his history, called NG or NDG (No Damned Good) by his shipmates; a senior officer, Fitch, a sonuvabitch who seems to be clawing for dominance in any way he can; rivalries, tensions, and hates. She befriends — beloves—Ramey and finds ways to unify a fair portion of the crew. But then she must go up against Fitch, and her past must emerge to make her an outcast, and . . .

Loki revisits Thule, and Fitch throws off the ship everyone but Bet, Ramey, and an aide. He slavedrives Bet into repairing two sets of battle armor, and as she learns why we begin to wonder with her. What is Fitch's game? Is he planning to take over the ship? The station? Is he loyal to self, ship, captain, or some cause? What are Bet's loyalties? And Ramey's?

You'll find learning the answers a satisfying experience, even if you have

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trouble with Cherryh's rapid-fire style. It takes getting used to, but it's effective. (It is also so distinctive that it invites parody; one of these days, someone is going to do a real number on Cherryh.)

Rob Chilson recently sent me the manuscript of his Questar book, **Men Like Rats,** saying that, since he's "a long time if minor member of the *Analog* Mafia," I might think the book worth reviewing. Well, that was enough to get me to look, and when the story immediately reminded me of something in the distant past, I read on. So here's the review.

What was I reminded of? Years ago, there was a tale where gigantic aliens (or perhaps their machines—memory is dim) came to Earth, ignored humanity and all else, bulldozed the place flat, and turned it into a farm. A few humans escaped by moving into the spaces within the walls of the alien spaceships—they would, they swore, live off the aliens in precisely the opportunistic way that rats had always lived off humans. And this is so precisely the background of *Men Like Rats* that I presume Chilson was responsible for the older tale as well.

The time of this tale is long, long after humans took up the rodent's ways. Earth is a fairy tale. The aliens have taken to setting traps, loosing animals intended to devour vermin, and spreading pesticidal plagues. But the humans have adapted, as we see when Chilson introduces us to the loner Rick and we follow him as he befriends a boy cast out of a nest of women as a surplus male, gets both of them into the nest and cast out again, breaks into shipping containers for supplies, moves off the ship to factories dominated by tyrannical savages, visits a farm-world and a food factory, fights ferrets and ogres and . . .

It's a magical wonder tour, it is, with no more real plot than might sustain a novelette. Nor are the characters much better than cardboard. But the wonders are there, the ways in which humans would have to adapt to such a situation, and then the ways in which the aliens would have to strike at them with mechanical and biological pesticides. There are no real surprises in the aliens' efforts. There is the pleasure of recognizing strong parallels to some of the more sophisticated ways in which humans attack their pests here and now.

Would you like a hint of the ending? Then try to imagine the possible consequences if screw worm flies looked like humans. That isn't quite what Chilson does, but if you can manage the trick, you will have some inkling of how any species as adaptive as our own might survive some pretty sneaky tricks.

Converts have as a distinguishing feature a large amount of enthusiasm or fervor for whatever they have converted to. If we share their enthusiasm, we cheer them on. If we don't, we say they have an "excess" of that enthusiasm and tell them to cool it.

I offer this comment on human foibles in a purely descriptive way, for by his enthusiasm, Barry Longyear shows that he is a convert. What he has converted to is sobriety and Alcoholics Anonymous. The enthusiasm showed and was thoroughly justified in his *Saint Mary Blue*, which I reviewed last fall. Now it surfaces again in quite a curious way in, of all things, what is billed as his first fantasy novel, **The God Box.**

The tale stars one Korvas, a rug merchant so crooked that he makes a corkscrew look straight. He is striving mightily to cheat a customer when he

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learns of an inheritance in the custody of the local temple of the Nants: A beggar whom he had long ago, and blindly, benefited has bequeathed to him a small chest of drawers with the curious property that it will give its owner whatever he needs (*not* whatever he wants) in exchange for whatever he doesn't need. Supposedly, the box contains a beneficent god. It is the god box of the book's title.

As Korvas scratches his head over this peculiar thing, he learns that his latest customer is related to Captain Shadows, the supernally vengeful and nasty head of the local secret police. He also learns that he is now part of a prophesied quest, a search for a hero who can defeat the god of destruction and preserve the world. And he is off, fleeing, questing, changing, growing, and learning that the thing he doesn't need most of all is his fear, his anxiety, his petty jealousy and envy. What he needs is . . . mostly, what he needs is to get rid of those negative features of his personality, so that he may then grow and change and blossom. He also learns that he can make a god box out of anything, even a pocket, and that anyone can make and have a god box of his or her own, one guaranteed to give them what they need.

Korvas enjoys numerous adventures and gains much advantage from the god box. And the book is a perfectly adequate fantasy quest with a number of nice touches. But that god box. That's the nicest touch of all, and when I was done, I wondered where I had heard of it before. In *Saint Mary Blue*, perhaps? I scanned through that book, searching, and couldn't find it. So I called Barry. He told me that maybe it was in *Blue*, but he couldn't think where. Of course, it did have something to do with that aspect of his life. He himself first heard of it at an AA meeting.

So. Enthusiasm. Barry's sermon to the fantasy fan, perhaps. It's a pretty good story, too. And that's precisely what we say of all the best sermons. Isn't it?

The Drawing of the Three, says Stephen King in his "Afterword," is the second of six or seven books which make up a long tale called *The Dark Tower*, all based loosely on, or inspired by, Robert Browning's "Childe Roland to the Dark Tower Came." The first volume in the series, *The Gunslinger*, set the tone: Roland, last representative of a culture that glorified the six-shooter, is madly, blindly, perhaps even gloriously obsessed with a Man in Black and a Black Tower, and pursues them both across a wasteland. At the end of the book, he catches the Man, gains a number of cryptic clues to the future, and sits, musing, on the seashore.

The Drawing of the Three opens immediately thereafter, when giant lobsters crawl from the sea and wound Roland, robbing him of two fingers he needs to be an effective gunslinger. Roland bandages himself, eats a lobster, and begins his long hike down the shore while infection sprouts, spreads up his arm, and assails him with fever and weakness. He comes to a lone door, standing on the sand, with no frame, no sill, no lintel, not even a back side. He opens it, and suddenly he is looking out at our world from inside the skull of a young heroin addict who is running cocaine for a mobster. Here is the first of three sidekicks he must draw to his world, on the other side of the door. But first, he must save Eddie Dean from customs, from his mobster boss, from the brother who rules Eddie with iron guilt.

Roland succeeds, of course. He even brings Eddie back with a handful of penicillin for his raging infection, and

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then, together, they proceed to a second door, where they discover the second of the three, Odetta Holmes, early civil rights activist, rich, legless from the time someone pushed her in front of a subway train, double personality from the time someone dropped a brick on her head from several stories above.[1] The main personality, Odetta, is kind, gentle, appealing, and Eddie falls for her immediately. The other, Detta, is a vicious, honky-hating bitch who would rather kill Roland and Eddie than eat. And the antibiotics were not enough. Roland's infection is returning, he is weakening once more, and Door Number Three awaits.

They reach it, and behind it Roland finds the nasty creature responsible for Odetta's plight. Riding him, he must hold up a pharmacy for more antibiotics and somehow heal Odetta. King descends into farce as he pits the gunslinger is against city cops, but the comic relief is welcome. We know by now that the gunslinger is invincible, that Eddie will soon be wholly on his side, that Odetta will be healed, and that the Three will be drawn for Roland's aid. (Or will they? Read, and see. King has a surprise or two up his sleeve for the end.)

The gunslinger's world is a world of elemental purity, one of stark contrasts, of honor, of responsibility, of Fates that design human lives with due attention to poetic justice. It is not our world. It is instead a surreal mirror that allows King to chide us for our idiocies. It is in fact the mirror, the looking glass, that Alice knew. But unlike Alice, Roland lives on the other side and from time to time steps through to visit ours.

From the comments that bracket the story in King's "Argument" and "Afterword," King seems to be fairly uncertain of how the public will receive his tale of Roland. It is not, after all, "a Stephen King story." But it is good, and it is worth reading, both for its example of a powerful writer who is daring to try something different and for its mirroring of humanity.

It's intriguing to think of what our reaction would be if some unknown writer had offered this tale as his or her maiden effort. I think—I hope—that we would be applauding mightily. We might even be offering awards. But I'm pretty sure we would not be making the author rich. It takes an established name like King's to make a story like this, no matter how good it is, a best-seller.

Still Forms on Foxfield was Joan Slonczewski's first novel, published back in 1980. I didn't review it then because, as I recall, I never saw it. I *did* review *A Door into Ocean,* which won Slonczewski the Campbell Memorial Award and got her publisher excited enough to reissue *Still Forms.*

Like the author's second book, this one is an intense reflection of her religious beliefs. She is a Quaker. But where *Door* centered on passive resistance as a way to cope with malign imperialism, *Still Forms* addresses the Quaker identity as "in the world but not of it," and considers how to cope with more benign cultural imperialism. As the world falls toward nuclear holocaust, a group of Quakers takes a starship off to the world they call Foxfield, where the environment is harsh and there are strange, plantlike creatures, the commensals, which in time prove helpful. A century later, a ship from Earth arrives in peace but full of insistence that the high-tech way of life created by the survivors of the holocaust is utopia. Citizens are linked by instant communication. All are sterilized, though

[1]King calls her condition schizophrenia even though multiple personalities are no part of that disorder. (Yes, I know that the common parlance is inclined to agree with King's usage.)

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their gametes are stored, and reproduction is via artificial wombs. God, the Light of the Quakers, is either dead or ignored.

There are less than a thousand Foxfielders. Earth expects them to permit immigration of at least a thousand of Earth's non-citizen rabble each year. And it will not permit them to say no, for it claims suzerainty over all humans, everywhere, and is sure it knows best. Foxfield's hope is that the One, the single organism grown from the fusion of countless commensals over the ages, will have something convincing to say on the matter.

Slonczewski's hand is less sure in her first novel than in her second, and she fails to edit out a number of extraneous elements. But the gift is clear: Here indeed is a promising writer. I hope she writes many more.

Here's another one I failed to review when it first came out: Nancy Willard's **Things Invisible to See.** It's fantasy, or perhaps just fancy, for it departs from reality in only a few ways. In the late 1930s, Ben Harkissian, fooling around, hits a baseball across the river, where it strikes a young girl, Clare Bishop, in the head and leaves her unable to walk. Ben, consumed by guilt, drops his materialistic girlfriend, Marsha, visits Clare in the hospital, and falls in love with her. Only when he is drafted for World War II does he confess. Meanwhile, we meet families, friends, and neighbors, all drawn convincingly and full of quirks with love and deftness. We see the lifestyle of the times, wants and all. We learn to care deeply about the characters and their fates.

We see no fantasy element that really matters (though there is some foreshadowing) until Ben, adrift in a lifeboat on the South Pacific, meets Death and strikes a deal: He and his buddies will play baseball against the best team the old man can dig up. If they win, they get a new lease on life. If they don't . . .

I'll tell you nothing more, except: Don't wait as long as I did to read it. It's a gem.

Moon Mirror is a collection of nine stories "by Andre Norton as selected by Ingrid Zierhut." I suspect that Zierhut's job was to mine Norton's trunkful of unsold or unsalable material. The stories are a hodgepodge of SF and fantasy heavy on "Oh, wow!" effusiveness and light on depth and subtlety.

Yes, some of the stories are tolerable. "Through the Needle's Eye" gives a young polio victim a sorceress of needlework, for a while. "The Toymaker's Snuffbox" and "One Spell Wizard" are fairy tales in the classic mold. "Teddi" picks up on *The National Enquirer*'s suggestion that we could solve the problem of resource shortages simply by making people smaller.

Most of the rest are pleasant enough but so totally unmemorable that I was not surprised to find no indication on the copyright page that any of the stories have been previously published. Certainly, if a newcomer to the field produced such things they would have trouble finding a publisher.

Don't waste your money on this one if you're expecting more of the Norton who introduced you—and a million others—to SF and fantasy.

Is it a magazine? Or a book? Call it **Pulphouse: The Hardback Magazine,** the best small-press original anthology I have seen in a long time. The second issue, for Winter 1988, is in fact so good that it outshines many big-press original anthologies. The reason is that editor Kristine Kathryn Rusch has drawn together what she calls "wild hair" stories, ones their authors had to write

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regardless of standard commercial marketability. They are therefore sometimes experimental, sometimes strange, sometimes filthy, sometimes funny, and always fresh and original and good (a few are even superlative). Try Nina Kiriki Hoffman's "Savage Breasts," for instance, or Michael Swanwick's "Foresight," in which he tries to remember the future. Try Ron Goulart's "Visitation," Spider Robinson's "The Paranoid" (a Callahan's-wife story), or . . . The total is 17 stories, plus essays by Algis Budrys, Jack Williamson, and Jon Gustafson, and not one of them a lemon. What more can you ask?

ANADEMS

David Hartwell edits SF for William Morrow these days. He is also the Reviews Editor of a new small press magazine, **The New York Review of Science Fiction,** the first three issues of which he recently sent me. The *NYRSF* is a new evolution of *"The Little Magazine,* which is now 22 years old and too expensive to continue." It "aims to become the leading review medium in SF. In addition, we will publish engaging and provocative essays on topics of interest to SF readers, and a variety of special entertainments—for instance, artwork and columns by Daniel M. Pinkwater."

Should I feel threatened? I don't think so, for the *NYRSF* reviews seem to be a mite more like criticism than mine and though the essays are smooth enough, they seem too likely to be of purely local New York or fannish interest, like Susan Palwick's "I Was a Teenaged Crud Fan," Parts one, two, and three. On the other hand, there are such expressions of dismay as Samuel R. Delaney's "Flow My Tears. . . : Theater and Science Fiction." And Pinkwater's a yuck.

If you're interested, send $2.50 for one copy, or $24 for a year's subscription (12 issues), to Dragon Press, P. O. Box 78, Pleasantville, NY 10570. Please make checks payable to Dragon Press, and payable in U.S. funds.

John Cramer's **Twistor** (Morrow, $18.95, 416 pp.) is being touted as such grand hard SF that James P. Hogan, Robert L. Forward, and Gregory Benford must shove over and make room. And it's not bad. The action is Hoganish and the characters perhaps worthy of Benford, while I think you'll find the whole fits the Forward mold fairly well, meaning it's dry and pedantic, with dialogue such as "Vickie calls it a 'twistor' field because of the way it twists and contorts the electric and magnetic fields. She's taking George William's quantum gravitation class now, and she says the time structure we impose on the field is an electromagnetic analog of one of the twistor operations in Roger Penrose's hyperdimensional calculus."

This style meant it took me a while to get very far into the story. But when I did, I found a good deal of story and technical whizbang to go along with the excruciating detail. Post-doc David and grad student Vickie are putting together the twistor rig while greedy senior prof Allan Saxon tries to survive the machinations of a megacorporate scuzzbucket. David and Vickie find that under the right conditions their twistor rig dips into another universe. Saxon freaks. The scuzzbucket gets a hint and sends thugs to steal everything. David and Vickie clinch. David and the two young kids of a helpful colleague flee the thugs by using the rig and thereby marooning themselves and giving Cramer a chance to add just a touch of *Swiss Family Robinson* to the mix. And then—eventually—it's happy ending time, of course. How Cramer gets his characters there I'll leave as an exercise for the reader. Enjoy. ■

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brass tacks

Dear Dr. Schmidt,

A few comments on my Anlab choices: two of my three picks for short story and one of three for novelette proved highly successful as bedtime stories for my children, aged four and seven. I hope the authors of "Twisters," "A Cat for Katie," "Guz's Place," and "Step Trolls" (which just missed out in my short story top three), would not be offended, but pleased at the broad appeal of their tales. For days, our house rang with shouts about "killer doughnuts;" and "Twisters," indeed, was such a success that a sequel was called for, which I had to invent.

Of course, some of the irony and sophistication in these stories had to be rubbed off for consumption by young folks. I thought the legal issues involved in Guz's case might be too complex to explain. But "Katie" and "Step Trolls" required no editing at all. Congratulations to these authors for crafting fiction that can send big and little persons to bed happy.

Short Story

1. "Twisters"
2. "Gravesite Revisited"
3. "A Cat for Katie"

Novelette

1. "The Worlds I Used to Know"
2. "The Steeldriver"
3. "Guz's Place"

Fact Article

1. "The Future of Disaster"
2. "An Introduction to Psychohistory"
3. "24th Century Medicine"

ALAN CLIVE

Silver Springs, MD

Dear Dr. Schmidt:

It has *never* happened before. I started toting up the stories for the 1988 AnLab, and Michael Flynn swept the novella/novelette category 1-2-3. Plus placing first, way ahead of the pack,

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with his article on psychohistory.

It reminds one of the days when Henry Kuttner was appearing all over the place in various name disguises, or, a bit later, when Silverberg was (by his own testimony) writing entire issues of *Amazing* under pseudonyms.

It ain't fair!

Anyhow: 1) "Remember'd Kisses"; 2) "The Adventure of the Laughing Clone"; 3) "Steel Driver."

Runners-up in that category: White, "Sanctuary"; Moon, "Too Wet to Plow"; Allen, "Thing's Ransom."

After that it was easy. Short stories: Elizabeth Moon, "The Generic Rejuvenation . . ."; Ashwell, "Thingummy Hall"; Jeppson, "Low Hurdle." Articles: 1) Flynn; 2) Benford's guest editorial; 3) John F. Carr's moving tribute to H. Beam Piper—let's not forget him. Covers: October—a lovely high-tech piece; December—the humorous opposite of same; February would make a striking poster or calendar.

Conclusions from the forgoing: it is nice to see some *humor* getting back into sf—real humor, not wheezes or slapstick or cute puns. It had been missing for far too long. And Michael Flynn is the most compelling new writer to turn up in your pages since the Campbell era.

PAUL CARTER

Tucson, AZ

Dear Dr. Schmidt,

Your editorial "Training Mission," (Jan. 1989) aroused my interest even more than usual. That may be because I'm a technical trainer. Whatever the reason, I was interested enough that I felt compelled to write.

In your editorial you cited an increased need for international cooperation to deal with such pressing problems as protecting the global environment and preventing nuclear war. You suggested that an internationally sponsored expedition to Mars would make a good training exercise for such cooperation; that the expedition might be "something which applies, on a relatively small and manageable scale, principles which you will later have to apply to bigger and harder problems."

I wonder if a Mars mission really would apply the necessary principles.

The problem I see is that such a mission would necessarilly involve only the industrial countries. The US and the USSR would run the show. Canada, Europe, and Japan would probably participate as bit players—if we really stretch China and India, too. Third World nations would be restricted to the audience. The advanced nations involved in the mission would be spending no more than they could comfortably afford. Poverty-stricken Third World countries would have no pertinent expertise or technology to donate.

If your goal is to deal with truly global problems, then the solutions—and training—must involve everybody. And will involve principles other than learning to trust an old enemy.

For example, one of the current problems in managing the global environment is the destruction of the rain forests. These forests consist of an exceptionally rich variety of plant and animal life, and are believed to be a major source of the world's oxygen. Their destruction would probably have large effects on the world's weather. The rain forests also exist almost entirely within the borders of Third World nations, and are the main natural resource for many of these nations. Mining and lumbering are destroying much of the forests, but the main destruction comes by converting the land to farming and ranching.

Brazil, for instance, has had an ag-

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gressive policy of moving its people into the Amazonian rain forest and converting it. On one hand, this is an admirable effort by desperately poor people to improve their lot through their own efforts. On the other hand, this may have serious, long-term consequences for the whole world.

Even assuming that a Mars mission leads to increased cooperation among advanced countries, how will that solve this problem? Poor Brazilians are unlikely to sacrifice their future at the request of rich Northerners (who have already devastated their own forests). Of course "cooperation" among the major powers could force Brazil to acquiesce. But a "shared-imperialism" isn't really what we're trying to accomplish, is it? And do the advanced countries have the power to do that without triggering a North-South world war? (Might not be as thorough as an East-West conflict, but still likely to make a pretty good mess of the world.)

The solution will have to involve cooperation with Brazil and some shared sacrifices. If Brazil is to give up the economic opportunity in converting its rain forests, some other opportunity will have to be made available. This almost certainly will conflict with the economic interests of some segments of the advanced nations. Since the benefits are not the fairly clear results of a Mars expedition, but very indirect and speculative (note all the qualifiers I used in describing the rain-forest problem) this will be a hard sell to everyone.

An expedition to Mars would be essentially a matter of engineering and project management. Bigger than any previous international project but not qualitatively different. Dealing with global problems involves much deeper and more difficult matters of politics and economics.

What would be a good training mission? Hard to say, but I'm fairly sure it would involve mundane activities here on Earth rather than space spectaculars (sigh, so much of life does). Still, something related to the Mars mission (at least conceptually) might work: joint research or development projects in Third World nations involving technology and wealth projects from the developed countries with insistence on attention to long-term economic and environmental consequences.

If this still sounds like the developed countries will be dictating to the developing—well, those with the money and knowledge always do. But part of the purpose of these projects should be transfer of these qualities to create a more equal relationship.

And that, I expect, is a prerequisite for true cooperation.

PATRICK M. HARVEY
Mountain View, CA

Dear Stan,

I have been reading *Analog* since 1963, at the age of 13. Being an avid collector, I have since that time, expanded my *Analog/Astounding* experience by another 30 years. In all this time, this is the first time that I have picked up my keyboard to write to you.

What brings me to this circumstance is statistical in nature. Having read the March issue from cover to cover (as is usual) I came upon Brass Tacks, the letters from your readers. Of the five letters written, three were written by reasonably major writers. Come on, Stan, none of those letters should have appeared there. I look forward to the very interesting commentary on your articles and editorials by your more mundane readers. The reply to Tom Easton's review was somewhat interesting, but should have been carried in

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his column, where the original review was aired. Not only would this have targeted it to the readers that originally read the review, but it would have shown great fairness on Tom's part. As it was, the reply/counter-reply sounded more like bickering. L. Sprague de Camp's letter was actually a guest editorial or opinion article. I would appreciate enormously if it could be given the space that the views warrant, instead of cramming them into the few columns at the end of the issue.

And finally, if one can believe the editorial opinions of the past, the letter by Arthur J. Ahrens deserves much more than being relegated to the rear. Including the picture at the bottom of the page, this letter took over a page of your magazine. How much better spent this would have been if it had appeared as a full page ad (donated by the magazine, after all its the same space) on, say, page five, with maybe a mention of the ad in the editorial (I had to use up the other half column somehow).

And besides all of this, I am ticked that you didn't point out to Chas. H. W. Talbot in response to point two that no teacher I know spends less that nine hours per day on teaching-related tasks. If Mr. Talbot thinks that papers grade themselves, student reviews write themselves, county state and federal paperwork grows on trees, Student/Parent/Teacher conferences happen during class hours, lesson plans for the unique group of students in each of one's classes can be purchased at the five and dime, then he should try to teach sometime. Most teachers I know count themselves lucky to average ten hours a day, six days a week. I don't know about Mr. Talbot, but after that kind of effort for nine and one half months I would need more than 10 weeks off.

Aside from the above, or maybe because of the above, keep up the good work. I expect to enjoy *Analog* for another 50 years.

ROBERT A. KARLIN
7628 Van Noord Ave.
N. Hollywood, CA 91605

Brass Tacks is intended largely as a place to continue dialogues started in stories, articles, and columns, and I can't justify excluding "reasonably major writers" from those dialogues. One of the strengths of the science fiction community is that it doesn't make as much "them versus us" distinction as many other fields.

As for teachers' real hours, I meant to mention that but it got squeezed out. I'm glad you brought it up.

Dear Stan,

In their "State of the Art" article for the March issue, Bova and Stine quote Jesco von Puttkammer as saying, "In all the first Moon landing stories ever written, science fiction never foretold the simple fact that mankind's first step on the Moon would be witnessed by billions on Earth through the medium of television." Unfortunately, this myth is one which sounds right—since science fiction is not primarily predictive—but is based entirely on inadequate research.

I quote from a letter by Gene DeWeese, published in the Dec. 1976 *Yandro*. "I just accidentally found out that it wasn't true. While shuffling all the magazines, etc., last week, I made the mistake of pulling out an old *Amazing* and reading/skimming the whole lead novel, *All Aboard for the Moon*, by Harold M. Sherman." (He goes on about how abysmally bad the writing was.) "But if nothing else, the landing on the Moon *was* televised and watched by millions of people all over Earth."

The story, according to my references, was in the April, 1947 issue of *Amazing*. I don't have a copy of that issue, so I'm relying on Gene's state-

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ment, but he's pretty reliable. He goes on to say that ". . . the camera televised the landing on automatic and kept right on transmitting a picture of the cliff they almost ran into for several hours while the entire crew was unconscious."

A year or two ago, there was an item in a fanzine which mentioned *another* story in which the Moon landing was televised, but I have no memory of the name of the story or the title of the fanzine in which it was mentioned. However, the foretelling has apparently been done not just once, but twice.

Possibly a mention in *Analog* will serve to reduce belief in this myth of a failure in prediction, though I expect that it's too well entrenched by now to die. It would seem to be safe to make all sorts of erroneous comments about science fiction, considering the vast number of atrocious stories that must be checked to refute them, but accidents happen, and science fiction fans tend to be omnivorous readers.

ROBERT COULSON

Hartford City, IN

Analog:

Mr. Shelley's "The Sylph" in the March '89 issue was worth the cost of the entire three year subscription to *Analog*. Good!

He sounds like the young Robert A. Heinlein. I have no higher compliment available for any man or author.

Mr. Shelley has told the truth about why men, from time to time, must be ready to risk their lives in battle or live as slaves. The story was reminiscent of the Boer War in South Africa. And he gave a good approximation of life on a farm; it brought me back to my childhood in the mountains of western North Carolina during World War II.

DAVID LOBDELL

W. Palm Beach, FL

Dear Dr. Schmidt,

I was very uncomfortable with the story "The Sylph," by Rick Shelley (March '89). I accepted the idea of sexual relationships with children as a story gimmick. But "gimmick" stories usually have some point to make. Given Mr. Shelley's emphasis on the two cultures' ignorance about each other, I thought the story would discuss the ramifications of a culture that emphasizes fertility over all other considerations and the ensuing conflict with a culture that does not. I found no such discussion. Then, I thought, perhaps Mr. Shelley is going to reveal that the leaders of this planet are so cynical that they would sacrifice their children to bind a conquered prisoner of war to them. No such revelation. So then I had to deal with the fact that Mr. Shelley had simply written a story about a middle-aged man who had a sexual relationship with a child and tried to show that this relationship was beneficial.

I can accept Mr. Shelley's ignorance of simple physiological knowledge but not yours. You have a reputation as a purveyor of scientific facts. Is "hard science" limited to cosmology and astronomy?

Here is a fact. The onset of the menses *does not* signal readiness to bear children. The onset of puberty in men precedes that last big growth in height. Remember when you got up every morning feeling like your legs were about a foot longer than they had been the night before? In girls, the onset of menstruation precedes the growth of the pelvic girdle. This is not a useless fact. Without the enlargement of those bones, girls die trying to birth the baby their bodies are capable of conceiving. Mr. Shelley does not seem aware of this. He keeps mentioning the support of the "compudoc" as though that would have some magical effect on the size of a

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child's bone structure.

Here is one more fact. Women who begin regular sexual relations at an early age (that is, earlier than sixteen to eighteen) have three times the rate of cervical and uterine cancer of women who do not. And yet Mr. Shelley creates the wonderable women of Wellman who begin sex and childbearing with the onset of menstruation and continue bearing children into their forties. Is "compudoc" a synonym for "magician"?

Before I hear you drag in the valiant frontier wives, I'd better say I've heard those stories before. I must have heard more accurately than you did, however. Dan'l Boone may have had two dozen children, but he also had four wives. My great-grandmother (the Indian-fighter, etc.) had eight children. Six survived to maturity. She was doing *very* well for those days. My husband's grandmother (the Indian-fighter, etc.) had twelve children and lost three or four in infancy. She was also doing very well for those days. Mortality rates of 50% were not uncommon among those patient frontier wives and their children. Of course, they didn't have any magical compudocs. Even today (without compudocs, I grant you), survival rates of mothers and infants are not quite 100%.

Mr. Schmidt, the reason most cultures ban sex with children is not because they (or we) are squeamish. It is because it is counterproductive. If an increase in the population is all that is desired, Clomid, available even today, will produce septuplets. Surely a compudoc could handle litters. In general, child brides produce weak children, few of whom survive to maturity, and end their child-bearing years early, because of exhaustion of the cervix and uterus due to cancer or early menopause (also a result of early or frequent pregnancies).

Consider for a moment, what would have been your reaction if Mr. Shelley had submitted a story to you in which the speed of light was stated to be 156 feet per second? You probably would have felt about the way I did when some ignoramus assumes that "if she bleeds, she can bear."

Give me a break, Mr. Schmidt. Don't fob me off (Did I say "fob"?) with "We wanted to start a controversy to broaden our readers' minds." This story isn't about controversy; it's about poor science, poor writing, and poor editing. Mr. Shelley could have done better. *Analog* has done better, so have you.

KAY SAUNDERS

Colorado Springs, CO

The author replies . . .

I am sorry that you were uncomfortable with my story "The Sylph." It *is* a story about culture clash, or culture shock, not just a matter of the two cultures in the story clashing, but the clash between the culture of the colony of Wellman and our own. I assure you that I am not ignorant of the physiological and medical arguments against early childbearing and sexual activity in our culture. But the practice of medicine is in large part a reflection of culture, and we are rapidly approaching the point where even physiological constraints may be regarded as "merely" a product of culture. In terms of our culture today, "compudoc" could be considered a synonym for "magician," *but* it is a magician who is already waiting in the wings to make his entrance. Given an apparatus able to closely monitor every part of a patient's body and also able to administer corrections (not "cures" or "therapeutic mutilation"—i.e. amputation or surgical removal of tissue) you have the ability to prevent or eradicate any disease and even to modify the basic physiological structure of the body. At present, it seems that the most likely

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candidates for introducing the corrections are molecular repair factories —nanotechnology. Cancer need not be any more of an eternal scourge than smallpox, polio, or even the "usual childhood diseases" such as mumps, measles, and chicken pox which—in terms of culture shock—have devastated peoples with no previous exposure to them. You may have seen the article on nanotechnology by Chris Peterson and K. Eric Drexler in the mid-December 1987 issue of *Analog*. Drexler has also published a book, *Engines of Creation*, dealing with the subject. And even if Drexler's optimistic projection that we could see the beginning of this technology extending life spans and so forth within 30 years is *too* optimistic, we will almost certainly see the *mature* technology in place before we start colonizing the stars. Does your culture require females to begin breeding at a very early age? Then adjust the genes of the first generation to promote early growth of the pelvic girdle. And cancer is no longer a threat when you have intelligent repair molecules holding up a template to the cells of the body and removing any that don't belong. Today that is magic. Even less than 100 years from now, it might be no more remarkable than vaccination against smallpox or polio.

Even today, advances in medicine cam come so quickly and be so dramatic that they can almost appear to be magic, even to the physicians who administer them. I have had personal experience of this in just the last few months (well after I wrote "The Sylph"). My father had suffered a number of major heart attacks over the previous 15 years and was in seriously declining health. In March of 1987, his cardiologist told him that two-thirds of his heart muscle was dead and that the next heart attack he had would probably be terminal, and that there was really nothing more that medical science could do but to use medication to put off that final heart attack as long as possible. Surgery was not even an option. The year before, my father had had surgery for a hernia and the surgeon only fixed half of the double hernia because he didn't think that my father could take the extra time to complete the procedure. Then, just this last October, when my father was taken to the hospital suffering another heart attack, we were all prepared for the worst. He was still not considered a good risk for open-heart surgery, but his cardiologists decided that that was the only thing that offered any hope at all. The surgeon told us that if my father survived the operation itself (and it became clear later that he did not expect that) he could expect to spend a month or more in the hospital recovering, instead of the ten days that it would take a patient in generally good condition otherwise. The doctors were all astounded that not only did my father survive the multiple-bypass surgery, but he was well enough to leave the hospital in 10 days. And today, less than four months later, he is in better health than he has been in for many years—to the continued amazement of his cardiologists and, according to them, thanks to recent refinements in the surgical procedure.

Seeing the "magic" that even a few years of development in medical science can bring makes it much easier to accept even more impressive "magic" over longer spans. Today, geneticists can identify the sites of defects in DNA that lead to certain inherited diseases. Correction is already a likely step, in the not-too-distant future. The rest is culture.

RICK SHELLEY ■

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a calendar of analog upcoming events

28 August-1 September
11th World Computer Congress '89 (IEEE) at San Francisco, Calif. Info: Stephen Yau, Chairman, Organizing Committe, University of Florida, CIS Department, Room 301, Gainsville FL 32611. (904)335-8006.

31 August-4 September
NOREASCON III (47th World Science Fiction Convention) at Sheraton-Boston Hotel and Hynes Convention Center, Boston, Mass. Guests of Honor—Andre Norton, Ian & Betty Ballantine; Fan Guest of Honor—The Stranger Club (Boston's first SF club). Registration—$80 (adult), $50 (child) until 15 July. Supporting—$20 at all times. No advance memberships after 15 July 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: Noreascon III, Box 46, MIT Branch, Cambridge MA 02139 or 76107,270 [CompuServ™]; NOREASCON 3 [GEnie™]; noreascon3@ringwld.UUCP or ringwld!noreascon3@XAIT.Xerox.COM or {decvax|linus}!xait!ringwld!noreascon3 [InterNet].

8-9 September
Austin Fanfair (media- and sales-oriented convention). Registration—$6 at the door; attendance estimated at 600-800. Info: Bulldog Productions, Box 820488, Dallas TX 75382. (214) 349-3367.

18-21 September
Oceans '89 at Seattle Sheraton Hotel and Tower, Washington State Convention and Trade Center, Seattle, Wash. Info: Ken Mohn, Honeywell, Inc., Marine Systems Division, 6500 Harbour Heights Parkway, Everett WA 98204. (206) 356-3000

22-24 September
BOREAL 11 (Francophone SF conference) at University of Ottawa, Ottawa, Ont. Registration $30 until 1 September, $35 at the door. Info: Boreal 11, % Jean-Louis Trudel, 410-2020 Jasmine, Gloucester ON Canada K1J 8K5. (613) 749-8050.

29 September-1 October
CONTEXT II (Ohio literary-oriented SF conference) at Columbus Marriot North, Columbus, Ohio. Guest of Honor—Jack Chalker. Registration—$18 until 1 May. Info: Fanaco, Inc., 376 Colonial Avenue, Worthington OH 43085.

23-27 August 1990
CONFICTION (48th World Science Fiction Convention) at the Netherlands Congress Center, The Hague, Netherlands. Guests of Honour—Joe Haldeman, Wolfgang Jeschke, Harry Harrison; Fan Guest of Honour —Andrew Porter; TM—Chelsea Quinn Yarbro. Registration—until 31 December 1989—$70 attending (£40, DM130, DFL140), $28 supporting (£16, DM45, DFL50), child under 14 $17 (£9, DM27, DFL30). This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Join now and get to nominate and vote for the SF Achievement Awards (Hugos) and the John W. Campbell Award for Best New Writer. Talks, panels, films, fancy dress competition—the works. Info: ConFiction, P.O. Box 95370, 2509 CJ The Hague, Holland.

—Anthony Lewis

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

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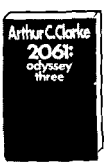

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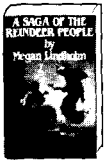

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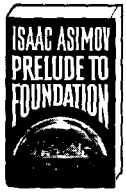

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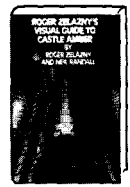

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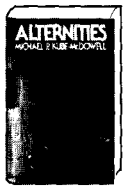

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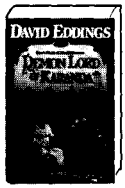

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